MAGNI MM-400

SER#MM-400-100

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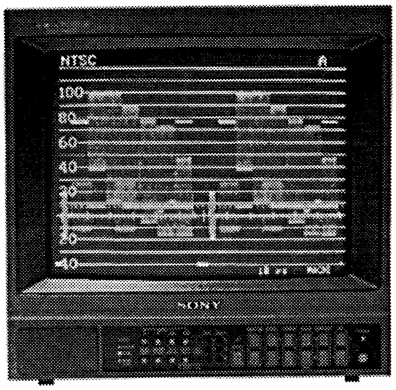
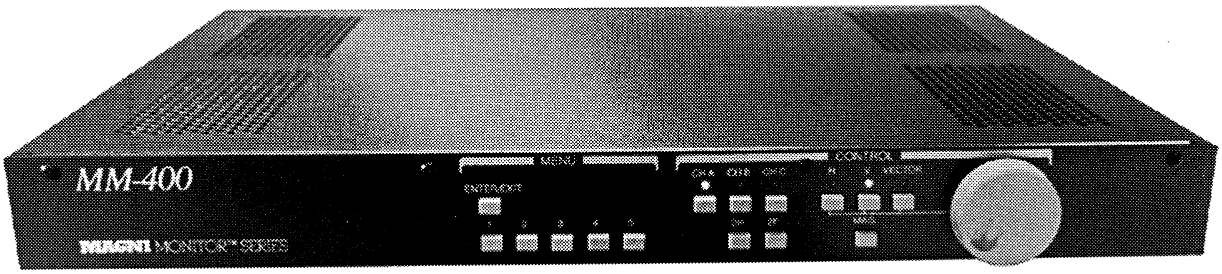


MM-400

MAGNI MONITOR

Multi-Standard

Waveform/Vector Monitor



Operator's Manual

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April 1993 946-5016-00 *933004*

Warnings and Cautions

Read and follow all safety instructions found in this manual.

CAUTION

RISK OF ELECTRIC SHOCK
DO NOT OPEN

- To reduce the risk of electric shock, do not remove covers.
- No user-serviceable parts inside.
- Refer servicing to qualified service personnel.

INSTRUCTIONS PERTAINING TO A RISK OF FIRE, ELECTRICAL SHOCK, OR INJURY TO PERSONS.

WARNING: THERE ARE NO USER SERVICEABLE PARTS INSIDE THIS ENCLOSURE. DO NOT ATTEMPT SERVICING UNLESS YOU ARE A QUALIFIED AND TRAINED SERVICE TECHNICIAN.

1. Introduction and Installation

Introduction

Description of Manuals

An Operator's Manual is provided with all MM-400 Series instruments; an optional Service Manual is also available.

Service Manual

The optional Service Manual discusses maintenance of the instrument. Included are:

- Block Diagrams
- Circuit Descriptions
- Calibration Procedures
- Schematics
- Board Diagrams
- Parts Lists

Service technicians are assumed to be familiar with television terms and measurement techniques also analog and digital circuit concepts.

Operator's Manual

The Operator's Manual discusses the operation of the instrument and its application in typical situations. Operators are assumed to be familiar with television terms and measurement techniques. The Operator's manual is organized as follows:

Chapters

1. Introduction and Installation. This chapter presents a description of the manual, an overview of the MM-400 Series, installation instructions, and lists of options and accessories.

2. Quick-Start Procedure. This chapter describes the basics of operation, both verifying performance upon unpacking, and giving the operator immediate hands-on experience.

3. Operational Description. This chapter describes in detail the front panel controls and indicators used to operate the instrument. All setup and operating modes are described here.

4. Applications. This chapter contains six Application Notes: Brightness and Contrast, NTSC Video, The Waveform Monitor, The Vectorscope, The Signal Generator, and Installation Suggestions. These easy-to-read application notes are intended to provide useful information to anyone working in video.

5. Specifications. This chapter gives detailed electrical, environmental and physical specifications.

Appendices

A1. General Service Information.

A2. Additions and Changes.

Equipment and Accessories

The first list shows equipment and accessories included with the MM-400, the second list shows the optional accessories available from your dealer or Magni Systems, Inc.

Included Equipment and Accessories	Magni Part Number
1 MM-400 Waveform/Vector Monitor	P/N 670-0302-01
1 Power Supply	P/N 295-0002-80
1 Power Cord	P/N 340-1100-80
1 Remote Control Shorting Stub	P/N 355-0002-00
1 Operator's Manual	P/N 946-5016-00
2 Brackets, Rackmount	P/N 485-0231-00
2 S-Video Terminator	P/N 357-0101-00
4 Feet, Polyurethane	P/N 448-0003-00

Optional Accessories

Remote Unit	P/N 670-0305-00
Telco Cable, Std. 6-Cond	P/N 325-0014-00
Rackmount (Full), MM, with Blank Panels	P/N MM-RACK
Half Rackmount, MM, with Blank Panels	P/N MM-HALFRACK
Manual, Service, MM-400 Magni Monitor	P/N 946-5017-00
Cable Accessory Kit that the following:	P/N MM400-CABLES
1 - Computer Interface Assembly	
1 - Calibration Interface Cable Assembly	
1 - Crimping Tool, modular 6-pin	
3 - 0.1%, 75 Ohm Terminators	

Product Description

As complex as production and transmission equipment became with today's rapid advances in video technology, there are some basics that haven't changed. The most critical is the need for a clean, undistorted signal at all points in the signal path. Few facilities however, can afford to invest in a complete test and measurement set for every key area. This is especially true since some advanced features found in CRT type monitors are not used on a day-to-day basis, but only in specific situations.

The MM-400 Magni Monitor is a waveform/vector monitor combination that offers a solution to this problem. The MM-400 provides you with a flexible, accurate and truly economical monitor that does not rely on the costly CRT as its display, but uses an ordinary picture monitor instead. Additionally, the MM-400 Magni Monitor is rugged, compact, easily installed, and highly suited for use in remote situations.

Feature Summary

Displays waveforms and vectors on standard picture monitors
    PAL and NTSC composite video,
    525/625 component analog video, and
    S-Video capability

Unitized Construction

- The MM-400 contains controls, inputs, outputs and remote connections
- The optional remote control allows selections to be made from a distance
- External power supply: 6 foot input and 3 foot output power cords

User-selectable color and intensity for backgrounds, graticules and waveforms.

SC/H Phase and color frame monitoring with alarm output.

Interchannel component timing monitoring with alarm output.

Easy-calibration.

Basic Information

The MM-400 has its own control panel and can support one remote control. Two display video outputs are provided and will support two picture monitor displays. Several loop-through equipped picture monitors may be used if more are needed, i.e., in a classroom situation.

Systems and Formats

The MM-400 supports most video formats within the 625/50 and 525/59.94 television systems. These include the NTSC and PAL composite standards, and GBR, M-II, Beta, SMPTE, EBU, and S-Video component video formats. System, standard and format selections are made from the control panel or from the optional remote control.

The MM-400 supports NTSC and PAL composite and component analog formats. The component inputs accept the different signals without additional adjustment when the correct system and format are selected. As part of the MM-400's support of S-Video, two sets of loop-through DIN connectors are provided on the rear panel to accept S-Video cabling.

Display

The CRTs (Cathode-Ray Tubes) used in traditional waveform monitors and vectorscopes have limited applications for many reasons. The depth of CRTs restricts the locations in which they may be used -- certain production panels, for instance, cannot accommodate them -- and, especially in cramped and/or poorly-ventilated conditions, the heat they generate is enough to cause them to read inaccurately and may adversely affect surrounding equipment.

The MM-400 produce waveforms (or vectors) as a composite (NTSC or PAL) video output which may be displayed on any standard picture monitor.

This innovative signal display method allows greater flexibility than is possible with CRT displays. For example, have you ever had to adjust a piece of equipment and at the same time squint at a waveform monitor some distance away to see the result? MM-400 offers a solution. Display the output of the MM-400 on a large easy-to-see picture monitor. The MM-400 also allows the picture and the waveform (or vectors) to be overlayed. In the overlay mode, as you make an adjustment you can see the effect on both picture and waveform on the same picture monitor.)

Additional applications are described in Application Note 6 - Installation Suggestions.

Color and intensity levels for the background, waveform and graticule are fully user-selectable, enabling custom settings for high or low-light conditions (Illuminant C or D). Easy identification of signal sources becomes possible in multiple-monitor situations, by simply color-coding the signals.

Because the feed to the picture monitor display is a standard composite video signal, it may also be routed, switched or recorded just as you would any other composite video signal.

Proprietary high-frequency dither circuitry incorporated into the MM-400 guarantees true diagonals and eliminates objectionable stairstep effects in the display.

Compactness

In facilities already crowded with the latest in video technology, making room for monitoring equipment, however critical that equipment may be, has always been a dilemma. The MM-400's compact design allows you maximum flexibility to incorporate this important function not only where it fits, but where it is needed.

SC/H Phase/Timing/Component "Vector" Display

Few parameters are more critical for monitoring purposes than SC/H phase. Yet many facilities cannot devote space or operator time to separate SC/H phase metering equipment.

The vectorscope mode of the MM-400 incorporates basic SC/H phase monitoring without additional hardware. An on-screen readout alerts the operator of errors -- an alarm signal is provided and may be enabled or disabled by the user, at his preference. No mode changes are required; SC/H phase monitoring occurs continuously, yet only becomes visible to the operator in the event of an error.

In component operation, the readout or alarm indicates interchannel timing errors greater than preset limits from a color bar input. When monitoring component colors bars, graticule limit marks are provided to monitor ± 5% and 5° errors in the B-Y and R-Y color difference components. These two displays together provide the basic information obtainable from a component vector display, but in a form which is easily understood.

Operational Simplicity

Using straightforward controls and a menu-based approach, the MM-400 is almost instantly operable by even novice operators. Channel selection, magnified modes, 2H and 2F displays, and H and V positioning are all available under one-button control.

Selections from the menu determine which feature is under control of the rotating knob: these include changing colors and intensities, display persistence, vertical gain, input reference, alarm, clamp, and paraded V position offset. Menu items will, like the waveform displays themselves, appear on the picture monitor screen.

Controls for channel selection, H/V position and vector phase are all provided with LED indicators, for easy visibility. The MM-400 controls and front panels have also been designed for maximum visibility in low-light conditions.

Calibration

Most calibration adjustments are Auto-Calibrating. To Auto-Calibrate, simply connect a Magni Signal Creator to the MM-400 and generate the special test signals: PAL AUTOCAL or NTSC AUTOCAL. Select Automatic Calibrate from the CAL menu, and, MM-400 does the rest.

The Auto-Calibration feature helps guarantee optimum performance from all your equipment under test and reduces the possibility of extended down time. See the Service Manual for more information.

Mechanical Installation

Three types of mounting are discussed here. In each case remember, that although the MM-400 produces little heat, you should keep the ventilation holes in the power supply and the top and bottom covers of the base unit clear of obstructions.

Mounting Types

Free-Standing Operation

The MM-400 is equipped with a convenient easy to read control panel and polyurethane feet allowing convenient placement on counters, desks, computer work stations, etc. The power supply can be placed in any out-of-the-way location.

Front Rack Mounting

The MM-400 is easily installed in an equipment rack by simply attaching the "rack ears" to the front of the rack and securing with rack screws. This mounting is most convenient since the front panel can be easily reached by the operator, and the wiring can be hidden.

Rear Rack Mounting

Since the MM-400 may be operated by optional remote control, and the output is a video signal that can be routed to any convenient picture monitor, the MM-400 can be placed in the most suitable location for signal monitoring. This could be, for example, in the back of an equipment rack. The rack ears on the MM-400 can be left normally installed or reversed to allow flexibility in mounting to the rear rails.

If the rack ears are installed normally, and the MM-400 is mounted to the rear rails, the front panel will face rearward making operation easy from behind the rack, or to conserve rack front-panel space.

If the rack ears are reversed, access to the cabling on the rear of the MM-400 is facilitated. The optional Remote Control can facilitate operation of the MM-400 in this case.

Additionally, there are two hole sets in the rackmount hardware. If the MM-400 is mounted to the rear rail of the cabinet, and the door of the cabinet is too close to the front panel for example, the MM-400 can be moved back in its mounting hardware three inches to allow clearance.

To reverse or reposition the rack ears, remove the screws from the side rails, relocate the brackets and reattach.

Mounting the Optional Remote Control

The optional remote control occupies only a half-rack space and may be located some distance from the MM-400 which is normally installed at the point of monitoring. The remote control is connected through a telephone jack.

Where rackmounting is not an option, the minimal depth of the remote control -- less than 2" -- means that the remote control can fit into places which cannot accommodate traditional equipment (see figure 1). The remote control can even be mounted on the front panels of other, bulkier pieces of equipment, or used on a tabletop.

The remote control is mounted with thumbscrews or a 10/32 screw.

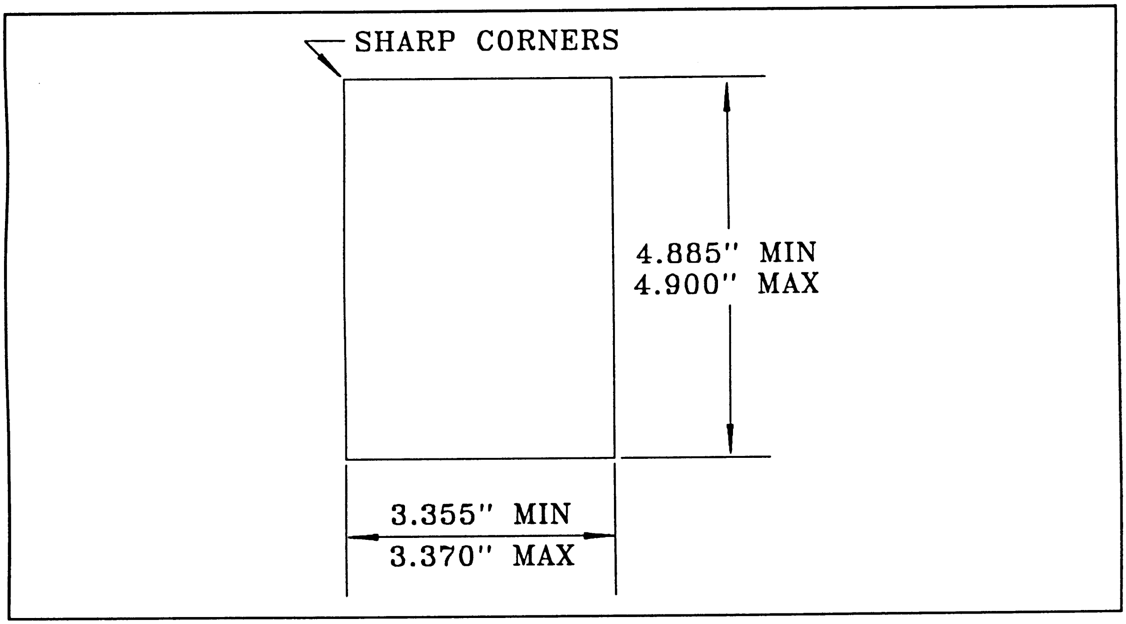


Figure 1 - Cutout for Optional Remote Control

Power Supply Mounting

The MM-400 power supply is external and can be mounted in any number of locations. For example, it can be placed at the bottom of the rack or console, or cable-tied to the back or sides. The separate power supply means the MM-400 generates minimal heat, which increases its stability and reliability.

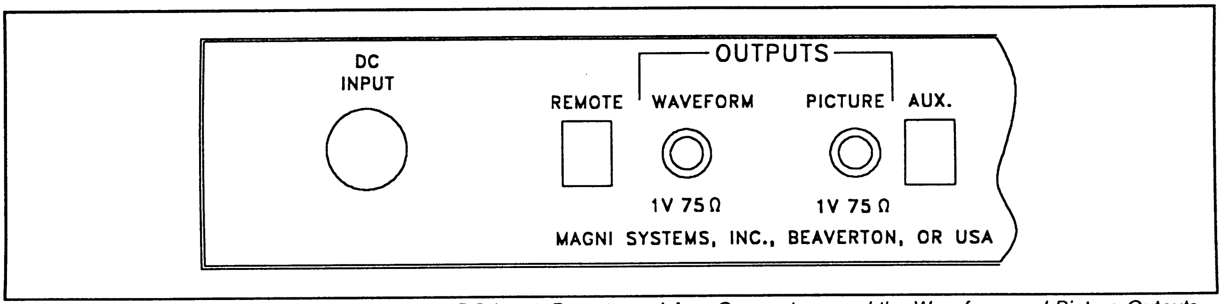


Figure 2 *- Rear Panel showing the DC Input, Remote and Aux. Connectors, and the Waveform and Picture Outputs*

Electrical Installation

Connecting the Outputs

Waveform

A BNC output connector on the rear of the MM-400 is provided to allow routing the waveform or vector video to a standard picture monitor. This is a standard video signal that may be routed in the same manner as any other video signal.

Picture

The picture output can be switched between three modes: waveform output only, a mixture of picture and waveform (or vector), or picture only. The picture portion you see depends upon which channel you've selected. For example, if you select CH A on the front panel, the video from CH A will be displayed.

NOTE >>> If you select External Reference you will see whichever signal is being input to the Reference connectors.

You can adjust the amount of picture/waveform mixture from the menus from full picture through full waveform. When you enter the menus, the picture/waveform display will disappear and the menus will be displayed.

The Picture output is a standard video signal that can be routed accordingly.

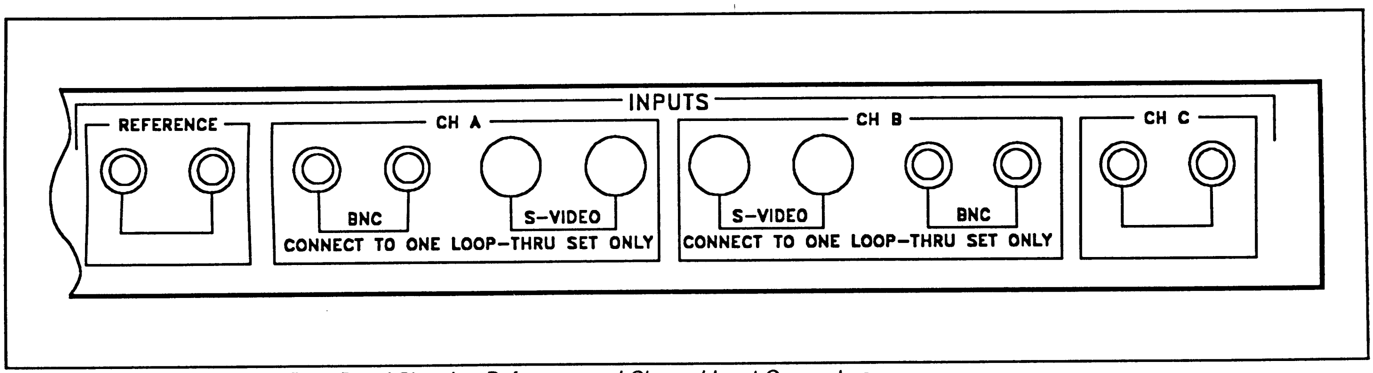

INPUTS
REFERENCE
CH A
BNC
S-VIDEO
CONNECT TO ONE LOOP-THRU SET ONLY
CH B
S-VIDEO
BNC
CONNECT TO ONE LOOP-THRU SET ONLY
CH C

Figure 3 - Rear Panel Showing Reference and Channel Input Connectors

Connecting the Video Inputs

The MM-400 has four pairs of BNC input connectors. Three pairs support the video inputs and one pair supports the reference input. Each pair of connectors is configured as a loop-through with either connector supporting an input or an output. Additionally, S-Video cables are supported by loop-through DIN connectors paralleling the BNC connectors on CH A and CH B. (In other words, you can input a signal to either one of the paired connectors and route the signal from the other connector to another piece of equipment.)

Important: Do not connect BNC and S-Video cables to the same input at the same time. Use only one set of connectors at a time. If you don't, you will see the sum of the two inputs resulting in inaccurate measurements.

NOTE >>> If the second connector of any input is not routed to another piece of equipment, that connector should be terminated with a 75 Ohm terminator.

Composite

The three inputs allow up to three composite video sources to be monitored individually (factory configuration), or simultaneously.

Component

The three inputs allow the components to be paraded on the waveform monitor display. The inputs should be connected so that: Y connects to CH A, B-Y connects to CH B, and R-Y connects to CH C. In GBR: Green connects to CH A, Blue to CH B, and Red to CH C. These connections are correct for the amplitude and phase limit boxes, and timing monitor.

S-Video

S-video signals can be input and output by connecting S-Video cables to the DIN connectors provided. If an S-video loop-thru is needed, simply use the adjacent connector for your output.

NOTE >>> If the second S-Video connector of any input pair is not routed to another piece of equipment, that connector should be terminated with an S-Video terminator.

Connecting the Reference Input

When multiple inputs are to be viewed, the reference input provides timing and subcarrier to lock the MM-400 so that timing and phase comparisons can be done. If more than one input is displayed, the unit automatically switches to EXTernal REFerence.

The EXTernal REFerence input may be looped-thru from one end of the video inputs, or it can be a separate signal that is timed with the signal inputs.

Connecting Inputs for Color Frame Matching

CH C may be compared to CH A or CH B for color frame matching when the SC/H and Color Frame monitoring is active in the vectorscope. Timing of the external reference must be within +/- 1/2 microsecond for normal operation. (If the reference is advanced relative to the selected input, a video delay can be inserted into the reference to offset the difference.)

NOTE >>> IMPORTANT: In the Component Mode, CH A should be looped-thru to the reference input to provide a sync reference source for multiple channel displays.

In the Composite Mode, it is recommended that CH C be looped-thru to the reference input and CH C be a reference view mode when CH C is selected.

Remote Control

The MM-400 provides an input for an optional remote control. The MM-400 can be controlled from the remote control, or via a modem over a telephone line. (For computer control)

The optional remote control interconnect cable is fourteen feet long. This cable is a standard 6-wire phone cable. Similar phone cables can be purchased in different lengths at phone or electronics stores. Having available different lengths of remote cable means that the optional remote control can be at your fingertips anywhere in your work environment.

NOTE >>> The REMOTE connector on the back of the MM-400 must have either a remote interconnect cable connected to a remote control or a remote control shorting stub.

Computer connections to the REMOTE input are explained on page 53.

2. Quick-Start Procedure

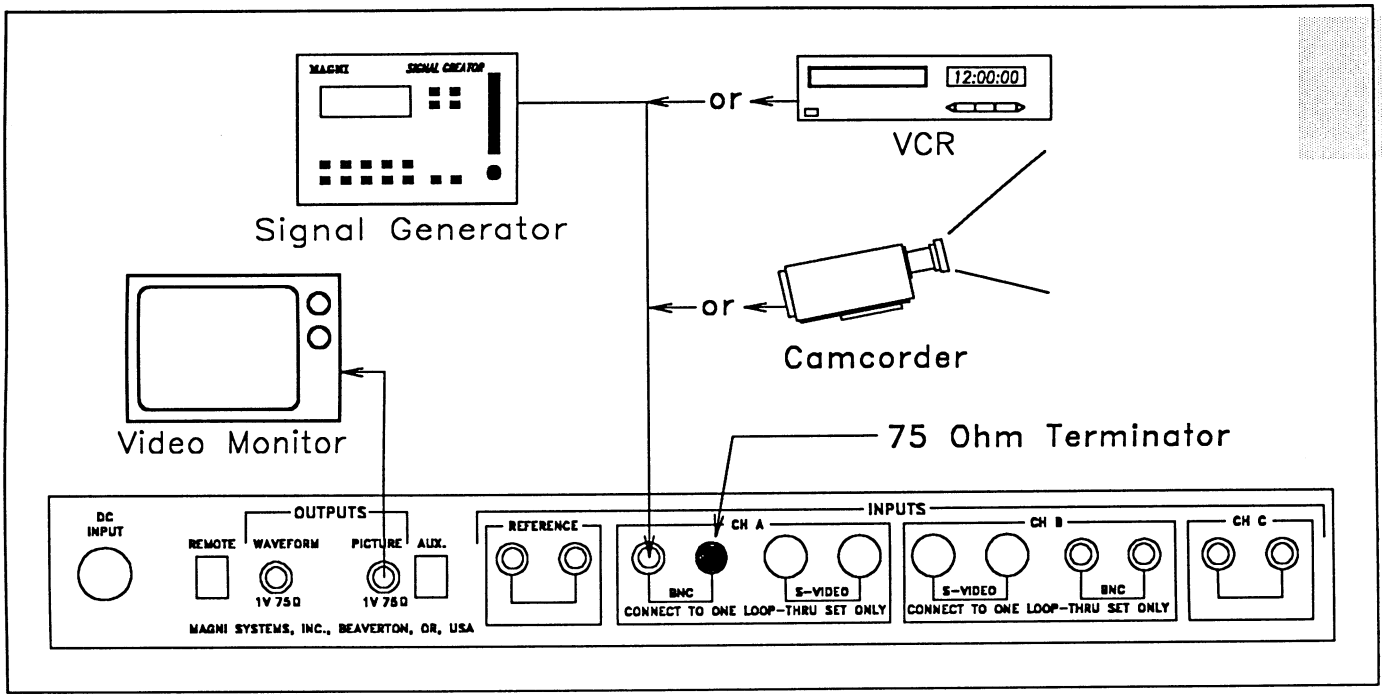


Figure 4 *- Hookup Diagram for Quick-Start*

Introduction

This chapter enables you to quickly become familiar with the MM-400. For an in-depth description of the operation of the MM-400, see **Section 3. Operational Description**.

Test Hookup

For purposes of testing the equipment before beginning the Quick-Start procedure, hook-up the MM-400 as is shown in Figure 4 and as described below:

Picture (Output Hookup)

Connect the Picture output to a composite picture monitor.

CH A (Input Hookup)

Connect a composite video source to the CH A Input BNC connector and terminate the other BNC connector of the pair with a 75 Ohm terminator.

Power Supply Hookup

Connect the 5-pin DIN plug from the power supply to the DC INPUT connector on rear panel. Connect the AC cord to the power supply and the other end to a power receptacle (90 - 250V, 50 - 60 Hz).

Initial Format Selection

The MM-400 is factory programmed to Auto Select your video standard when a signal is applied to the input. If when you first hook-up your picture monitor, the image on screen may be distorted, hook-up a video signal to the input of the MM-400 and the screen should clear-up.

If an input is connected, and the screen and menus are still distorted on your picture monitor, Auto Select may be disabled. To manually configure for PAL, push ENTER/EXIT, 5, 1, 2 on the control panel in sequence. To manually configure for NTSC, push ENTER/EXIT, 5, 1, 1 on the control panel in sequence.

Checking-out the Control Panel

Experiment with the control panel by performing the following:

Input Selection: Push CH A to select channel A, push CH B to select channel B and cancel channel A, push CH C to select channel C and cancel channel B. Push CH A to cancel channel C back to Channel A. (Input Selection is factory configured in the self-canceling mode. You may change to another configuration through the setup menus.)

Vector/Waveform Selection: Push VECTOR to change to the vectorscope mode (if your input signal is not Color Bars, this won't mean much yet.) Push either H or V to change to Waveform Monitor mode.

Waveform Mode

V(ertical) Position: Push the V button, and position the display using the knob.

MAG: Vertical: With the V LED on, push MAG (Magnification factor 2.5X). Move the knob to re-position the baseline to (for example) the top of the waveform being displayed. Push MAG again to leave the V MAG mode. Re-position the display using the knob.

H(orizontal) Position: Position the display horizontally by pushing the H button, then adjusting the knob.

2 Line (H Sweep Rate): Push 2H to see the 2 Horizontal Line display. (For 1H selection see p. 23)

2 Field (V Sweep Rate): Push 2F to see the 2 Field display.

MAG(nifier) Horizontal: With the H LED on, push MAG. Move the knob to re-position the baseline to (for example) the sync pulse. Push MAG again to leave the H MAG mode. Re-position the display using the knob. (See p. 23 for .2 usec/div, and X50 mag.)

Vector Mode

Input a Color Bar signal if available, and push VECTOR to change to the vectorscope mode. (You cannot see much with other signals, however, you should be able to see color burst along the X axis.)

Phase: In the Vector, rotate the knob to adjust vector phase.

MAG: Vector Gain: Push MAG to increase vector gain (Magnification factor 2.5X). Push MAG again to switch MAG off.

Menu Selection

Now that you are becoming familiar with the basic functions, you should know that there are more features to be found under the menu structure. Push ENTER/EXIT to display the menus. The functions within the menus are selected two ways: directly, or by toggling the function on and off.

Direct Selection

EXAMPLE:

Push the ENTER/EXIT button, push 3 to select **3 INPUT FUNCTIONS**, push 3 again to select **3 FILTERS**, push 1 to select **1 FULL BANDWIDTH**. Notice that the number of the button pushed (1) corresponds to the number beside the function name (1 FULL BANDWIDTH). Notice also that when a selection is made the menus disappear so you can see the result.

Toggle Functions

EXAMPLE:

Push ENTER/EXIT button, push 1 to enable VARiable GAIN, rotate knob to change gain.

Push ENTER/EXIT button, push 1 to disable VARiable GAIN.

Other Menu Operations

To exit the menus, push ENTER/EXIT button.
To back up one menu, push 2H.

Hook-Up for Quick-Start

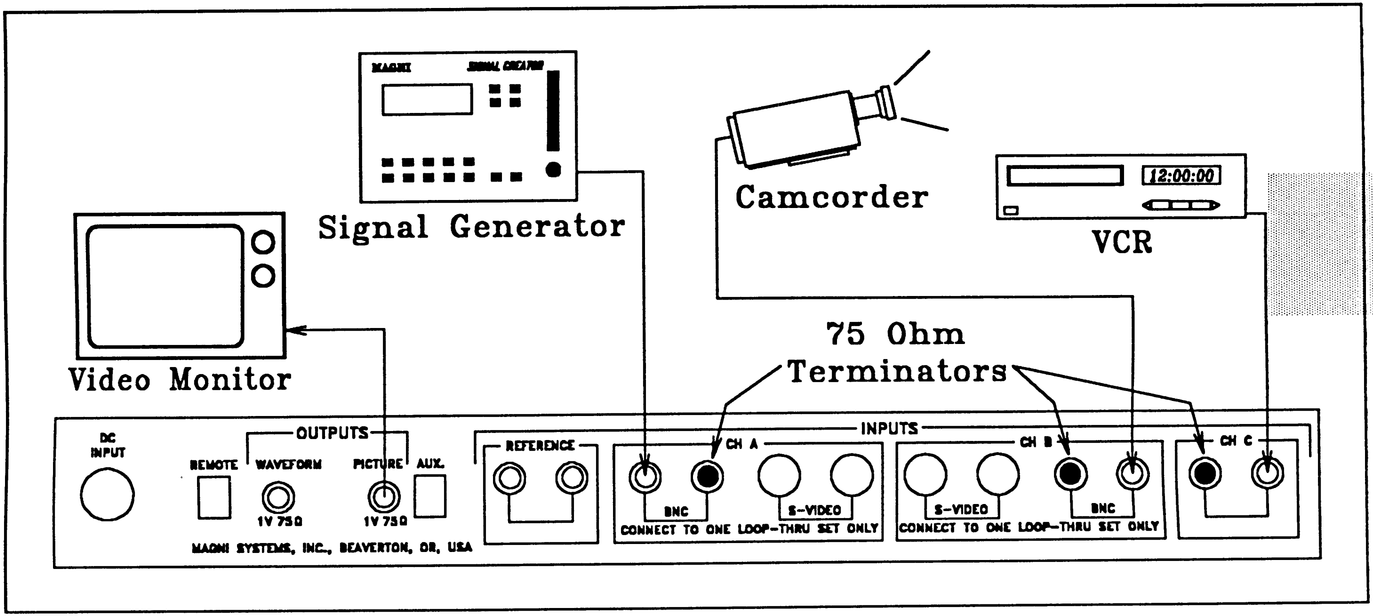


Figure 5 - Basic Composite Hookup for Three Inputs

Input Connections

CH A, CH B and CH C Inputs

Composite:

Connect a signal generator or other signal source to CH A on the rear panel and terminate in 75 Ohms. Connect other composite signal sources (if available) to CH B and CH C.

S-Video:

Connect an S-Video cable from your S-Video source (Camcorder, VCR, etc.) to one of the DIN connectors adjacent to CH A. Connect a terminator to the other S-Video DIN connector. Be sure that no cables are connected to the BNC connectors when using S-Video. If you have another S-Video source, connect it to the DIN connector adjacent to CH B, and terminate the other connector.

Component:

Connect a two-wire or three-wire component signal source to CH A (Y, Luminance, or G), CH B (C, B-Y, or B), and CH C (R-Y or R). Select CH A, B and/or C.

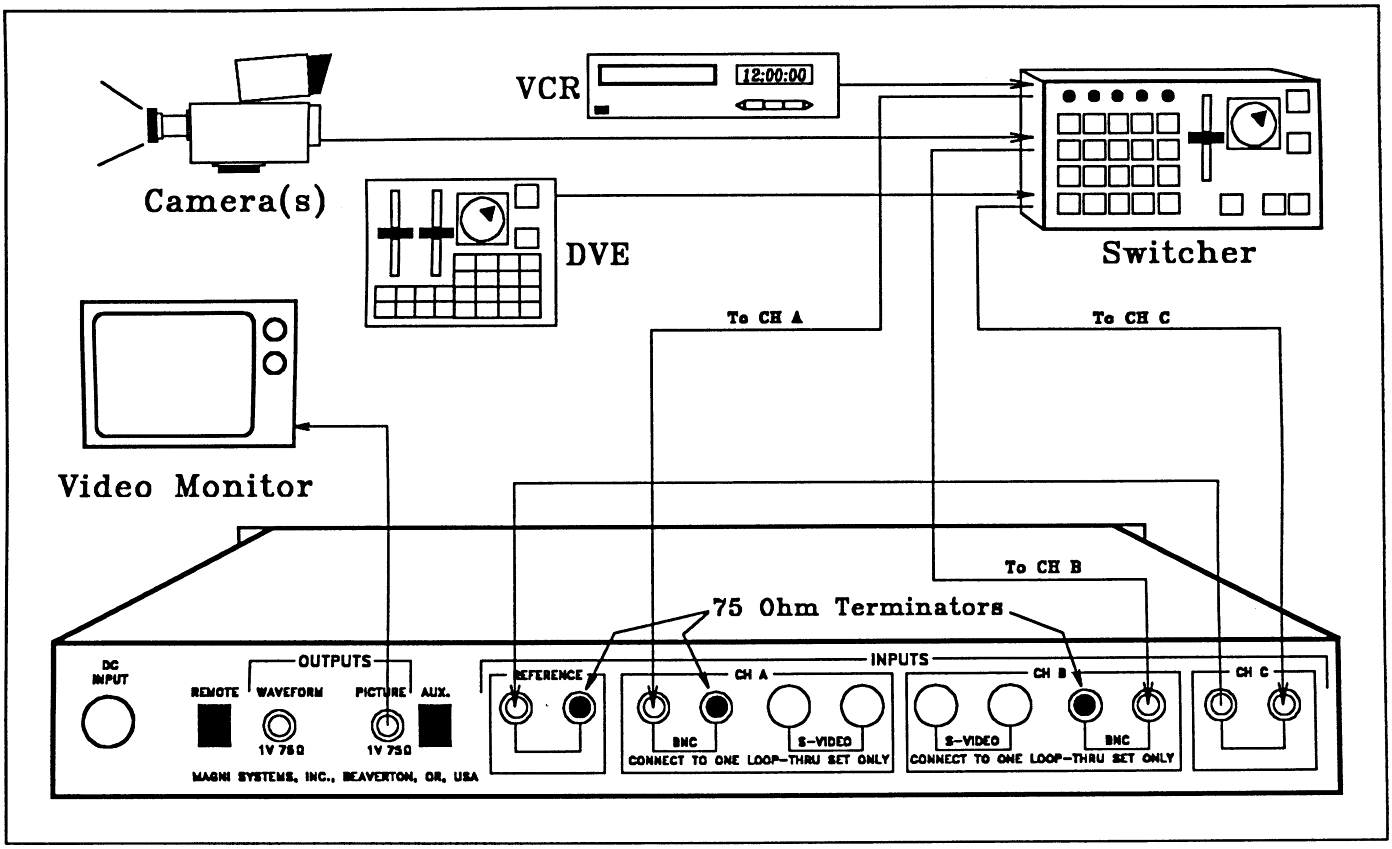


Figure 6 - External Reference Hookup for Color Frame Monitoring

EXTernal REFerence Input

Composite:

If Color Frame monitoring is to be enabled, connect the signal from CH C loop-thru to EXTernal REFerence. EXTernal REFerence must be connected when multiple channels are enabled.

Component:

Loop CH A through to the EXTernal REFerence input or provide a separate timed external reference signal if no sync appears on the input signals.

Output Connections

Picture

The PICTURE output provides a display of the input video. Three distinct displays are available: waveform only, picture mixed with waveform (or vector), and picture only. Identical buffered outputs are provided through BNC and 6-pin phone jacks.

Waveform

Waveform or vector is always available on the waveform BNC.

Optional Remote

This 6-pin phone jack connects to the remote control via the 6-pin phone cable. When a remote control is not connected, the jack should be occupied by the remote control shorting stub provided.

Initial Setup

Format

Select ENTER/EXIT, 5, 1, to enter the Format selection menus. Select the format appropriate to the signal you've connected. Select NTSC or PAL if you've connected S-Video or composite signals, 525 or 625 Component if you've connected component signals. (If you select 525 or 625 Component, additional component menus will appear. Make these selections at this time.)

Display

Select ENTER/EXIT, 5, 2 to enter the Display selection menus.

Waveform:	Color/Intensity/Persistence Allows setup of the waveform portion of the display. (Vector or Waveform)
Graticule:	Color/Off/Limits Allows setup of the graticule portion of the display
Background Color:	Sets screen background color
ID Label:	Added into graticule to identify video output
Picture Mix:	Allows setting the amount of waveform mixed with picture

Reference

Internal/External:	Set to EXTernal if Component or Multiple Channel and a reference signal has been connected to the reference input

Miscellaneous

Channel Selection Mode:	Set to self-cancel for single channel operation
Timing(w)/SC/H(v):	Enable/Disable Detection Limits and Alarm
Quick-Keys:	Leave disabled
VCR/Crystal Lock:	Crystal Lock is more stable on non-VCR signals
Waveform(w)/Vector(v) Calibration:	No change

3. Operational Description

Control Panel Operation

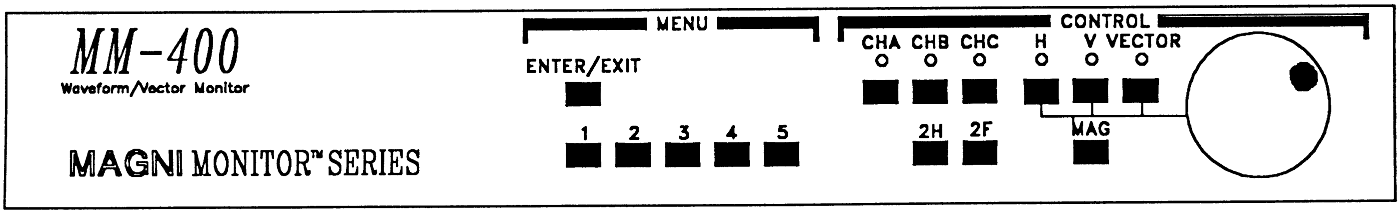


Figure 7 - Control Panel Layout

Nine buttons to the right of the control panel (See Figure 7) perform the most-used functions. These are: CH A, CH B, and CH C (Input Selection), 2H (2 Horizontal line display), 2F (2 Field display), MAG (H and V Magnification), H and V (selects Waveform), and Vector (selects Vector). H, V and Vector select which MAG is active. The knob provides the adjustment of H and V Position, Vector Phase, and other variables selected from the menus. Refer to **Section 2. Quick-Start** for further details.

Channel Selection

Single Channels

You may select individual channels by pushing CH A, CH B, or CH C. The corresponding LED will light to indicate the channel selected. The timing reference for single channel selection can be either INTernal (from the input signal) or EXTernal (from the EXTernal REFerence signal). The Picture Output will show the signal connected to the Reference Input whenever External Reference is selected.

Multiple Channels

Pushing a second or third CHannel button allows you to display a parade of two or three channels. If multiple channels are selected, the reference will automatically change to EXTernal. Additionally, the signal being input to the reference connectors will be output from the Picture connector. The single-channel selection mode (factory default) prevents selecting multiple channels. To change the setting, see below.

Channel Selection Options

The action of the channel selection buttons may be configured in three ways. From these three selection modes, you should be able to pick one that operates satisfactorily for you.

Single Channel (Factory Setting)

If only one channel needs to be on at a time, select the Self-Canceling mode. In this mode, pushing a channel button selects that channel and cancels the others.

EXAMPLE:

To select Channel A just push Channel A. To select Channel B, push Channel B. To select Channel C, push Channel C. The other channels will be automatically canceled for you.

Push On - Cancel

Push to select channel; push again to disable other channels. Once you are used to it, this method of selection is faster and easier to use than the normal push-on, push-off methods found on oscilloscopes.

EXAMPLE: To select a single channel, push that channel button twice. (The second push cancels all other channels.)

EXAMPLE: To select multiple channels, push the first channel button twice. Then push the buttons of the other channels that you want to view. Multiple channels are paraded across the display in the same order as the Input readout (upper right corner of the display).

Push On, Push Off

This is the normal oscilloscope selection method: push-on, push-off. This method requires a time-consuming sequence of decisions even to view a single channel.

EXAMPLE:

If you want to view CH A only, the selection sequence would be as follows: Look at the CH A LED. If off, push the CH A button, if on, look at the CH B LED. If CH B LED is on, push the CH B button to turn the LED off. If the LED is off, to look at the CH C LED. If the CH C LED is on, push the CH C button to turn the LED off. If the LED is off, you have finally selected CH A.

You must go through a similar sequence to get multiple channels.

2H (Two Horizontal Lines)

When in the Waveform mode, this button selects the two horizontal line display. (Or one horizontal line when one-line selected from menus.)

2F (Two Field)

When in the Waveform mode, this button selects the two field display.

MAG (Magnifier)

The MAG button allows the display to be magnified. The H, V, and Vector buttons determine which axes or display will be magnified. The MAG button has functions depending upon the mode you are in:

Waveform Mode

If the H LED is on and you select MAG; H MAG (Horizontal Magnification) will occur. If the V LED is on and you select MAG; V MAG (Vertical Magnification) will occur.

To activate both H and V MAGs: select H, then select MAG (this gets you into H MAG). Select V, then push MAG again; "Viola" you've activated both H and V MAGs. Since MAG is a toggle function, to get out of H and V MAG requires that you: select H, push MAG (turns off H MAG), select V, push MAG (turns off V MAG), and you're back to the normal display. (H and V MAG can be entered and exited from V MAG as well as H MAG.)

The magnification factors for the various Waveform mode are as follows:

MAGNIFIER VALUES	
Vertical:	2.5X
2H: 2H	1 μsec/division
1H	200ns/division
2F: Blanking:	Displays vertical blanking period*
Sync:	Displays vertical sync period*

*1H o 2H and Blanking (width) or Sync (width) MAGnification is selected from the Sweep Speed menu.

Vecto Mode

Pushing MAG in the vector mode activates Vector MAG. The magnification factor is fixed at 2.5X.

H (WFM)

The H button has three functions depending upon the mode you are in:

Waveform Mode

1. Selects Horizontal Display Position which is controlled by the knob.
2. Selects the function of the MAG button to allow the Horizontal (Sweep) MAGnifier to be toggled off and on.

Vectorscope Mode

3. Selects Waveform mode if you are in the Vector mode.

V (WFM)

The V button has four functions depending upon the mode you are in:

Waveform Mode

1. Selects Vertical Display Position which is controlled by the knob.
2. When two channels are displayed, the V Position toggles between: All V Position and the Second Channel V position. (Additionally, when three channels are displayed, the V Position toggles between: All V Position, Second Channel V Position, and Third Channel V Position.)
3. Selects the function of the MAG button to allow the Vertical MAGnifier to be toggled off and on.

Vectorscope Mode

4. Selects Waveform mode if you are in the Vector mode.

Vector (VEC)

VEC mode only

Selecting Vector changes to the Vector mode if you are in the Waveform mode. Once Vector is selected, the knob becomes the Vector Phase control and the MAG button magnifies the vector display. Pushing H or V returns you to the Waveform mode.

Quick-Keys

Buttons 1-4 become "Quick-Keys" when activated through the menus. Quick-keys allow you to change certain often-used functions from the front panel without going through the menus. Note however that when menus are displayed, Quick-keys become inactive so that the buttons can make selections directly from the menus.

Quick-keys are disabled when you receive your instrument to ensure that, initially at least, control access is only through the menus.

The Quick-Key numbered buttons operate as follows:

Waveform Mode

1. Toggles VARIABLE GAIN (ENABLE/DISABLE).
2. Selects 2H/1H (in 2H), EVEN/ODD Field Trigger (in 2F)
3. Toggles through the FILTERS (Full, Low Pass, Bandpass, Parade).
4. PICTURE OUT: WAVEFORM ONLY, PICTURE/WAVEFORM MIX, PICTURE ONLY

   Toggles waveform, a mixture of picture and waveform, or picture only from the PICTURE output connector. When an alarm sounds however, pushing button 4 disables the alarm but does not switch the picture output modes. The alarm for SC/H, Color Frame or Timing error may be enabled again through the menus.

Vectorscope Mode

1. Toggles VARIABLE GAIN (ENABLE/DISABLE).
2. Selects 75%/100% vectors.
3. Toggles +V (ENABLE/DISABLE) in PAL.
4. PICTURE OUT: WAVEFORM ONLY, PICTURE/WAVEFORM MIX, PICTURE ONLY

   Toggles waveform, a mixture of picture and waveform, or picture only from the PICTURE output connector. When an alarm sounds however, pushing button 4 disables the alarm but does not switch the picture output modes. The alarm for SC/H, Color Frame or Timing error may be enabled again through the menus.

NOTE >>> Selections made with Quick-Keys will not be saved upon power-down. To save these selections, the changes must be made through the menus.

Graticule Description

Waveform Monitor Graticule

For a complete description of the various markings on the Waveform Monitor Graticule, see Application Note 3 - The Waveform Monitor.

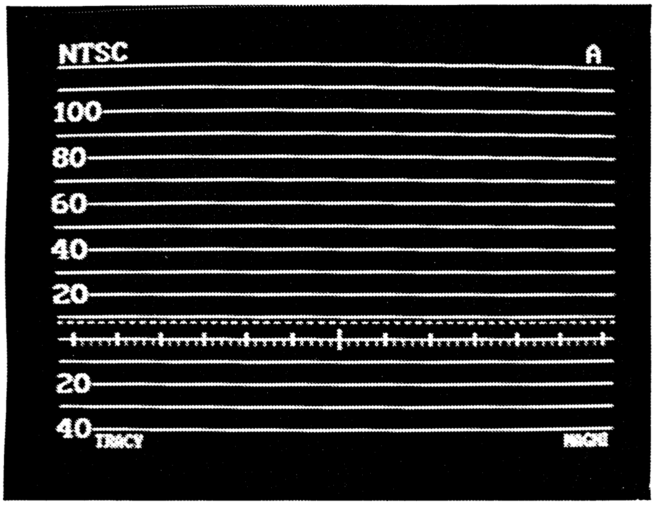


Figure 8 - Waveform Monitor Graticule

Vectorscope Graticule

For a complete description of the various markings on the Vectorscope Graticule, see Application Note 4 - The Vectorscope.

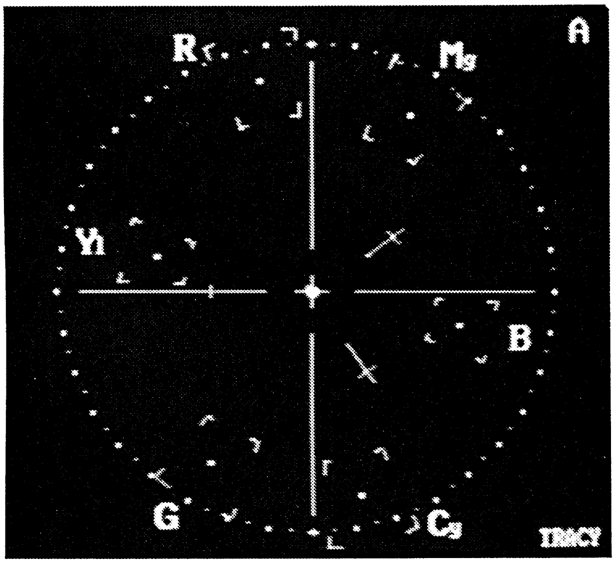


Figure 9 - Vectorscope Graticule

Readouts

Several readouts are displayed with the graticule to provide instrument status. These are: Format, Gain, Reference, H or V MAGnification, Channel and ID. In addition, when in the Vector mode the readouts inform you whether the display is calibrated for 75% or 100% Color Bars or whether SC/H Phase is within tolerance. The readouts switch on and off with the graticule and follow it in color, etc.

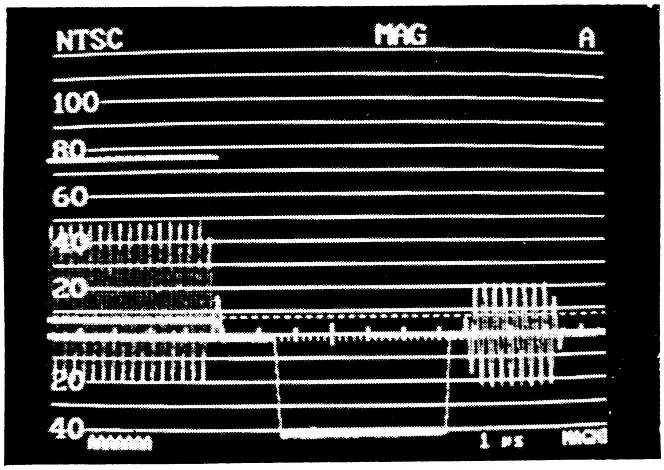


Figure 10 - *Waveform Monitor Display with Readouts*

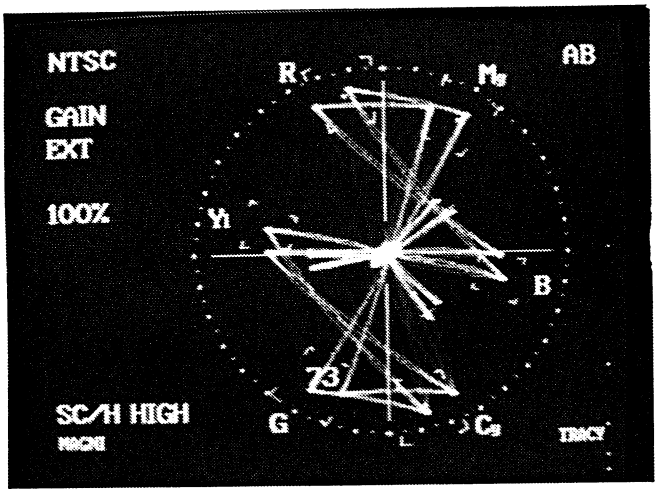


Figure 11 - *Vectorscope Display with Readouts*

Format

This portion of the display shows the input standard (NTSC or PAL) or format (GBR, SMPTE, BETA, MII, and EBU) in which the instrument is operating.

Sweep Speed

Shows the selected sweep speed in both normal and MAG modes.

Gain

This shows you whether the variable GAIN has been enabled or disabled. When GAIN is displayed, the knob changes vertical gain unless another function has been selected (i.e., H or V). If GAIN is not displayed, the instrument is in the calibrated gain mode.

Internal/External Reference

This shows you whether the instrument is set to internal or external reference.

Magnifier

This tells you whether the instrument is set to MAGnify the Horizontal axis (select H position first) or, Vertical axis (select V position first) or, the vector display (select Vector first). If MAG is not displayed, the magnifier is disabled.

Input

This portion of the readout indicates the input or combination of inputs selected by the front panel. The readout indicates the order in which the inputs are paraded.

75%/100% Vectors

This readout, active only in the Vector mode, informs you if the instrument is calibrated for 100% or 75% Color Bars. If 100% appears at the left of the display, the instrument is calibrated for 100% Color Bars, if nothing appears, the instrument is calibrated for 75% Color Bars.

SC/H Phase and Color Frame O.K.

This readout, active only in the Vector mode, informs you if the instrument is within the selected error range for SC/H Phase and Color Frame (10, 20, or 40 Degrees as selected through the menus) by indicating O.K. If the signal is out of tolerance, the readout will state: SC/H LO or SC/H HI depending upon whether the subcarrier phase is ahead of (HI) or behind (LO) horizontal sync.

Component Timing

Readout of error will be at the bottom center to indicate:

```
*****: Color Bar not found
B DLY: CH B delayed relative to CHA
R DLY: CH C delayed relative to CHA
B ADV: CH B advanced relative to CHA
R ADV: CH C advanced relative to CHA
```

Menu Operation

The on-screen menus provide a user-friendly method of implementing the more complex features available on the MM-400. Beneath the MENU header in the center of the control panel are six buttons; an ENTER/EXIT button, and buttons numbered 1 through 5. The ENTER/EXIT button enters and exits the menus, the numbered buttons select features within the menus.

Menu Access and Selection

To access the menus, just push the ENTER/EXIT button. To make a selection, push the numbered button corresponding to the number shown in the menu to the left of your selection. (Keep in mind where appropriate, the knob provides the adjustment once the function is selected.) To exit the menus, push the ENTER/EXIT button again.

Selection of Toggle Functions

Selections within menus that **toggle** (switch On and Off) are a differentiated from other functions by their colors.

As before, pushing the numbered button corresponding to the number to the left of your menu item selects the function. Upon selection, a message appears confirming the new instrument status. Once the message disappears, notice that the menu item has changed to reflect what will happen if it is selected again.

EXAMPLE:

If you see this menu item displayed:

1. **ENABLE** VAR GAIN

The word ENABLE in the line above means the variable gain function is currently Disabled, and selecting this item will Enable the function. As mentioned, a status message momentarily appears. After the message disappears, the menu item will then read:

1. **DISABLE** VAR GAIN

The word DISABLE indicates that the variable gain is currently enabled, and that if you select the item you will disable the variable gain. Simple yes? (Don't worry you'll get used to it.)

Menu Tips

Back One Menu

Once you select a menu, then make a selection within that menu, the instrument immediately switches back to the display. If you select a menu but don't wish to activate any of the items, you can return to a previous menu by pushing the 2H button.

Menu Preview

Rotating the knob once you have selected menus will provide a menu preview function. An arrow will appear at the left of the number and menu items that will come up when that number is selected will be displayed at the bottom of the menu. Select menu items as usual.

NOTE >>> Some menu items select a mode but when selected again, do not return you to the previous mode. These items require that another menu item be selected to restore the selection. For example: Once the Graticule is turned Off, to restore the Graticule you must select either SC/H Phase or Timing.

Vector Menu Overview

The menu structure shown below is found in the Vectorscope mode.

```
           VECTOR MENU
1 ENABLE (DISABLE) VAR GAIN
2 75% (100%) VECTORS
3 ENABLE (DISABLE) V AXIS (PAL)
4 * RESET *
5 SETUP FUNCTIONS (See Page 38)
```

Description of VECTOR MENU Functions:

1. Variable Gain

Variable Gain allows you to temporarily change the gain of the instrument to accommodate signals that do not conform to properly calibrated levels. For example: If a signal travels some distance through coax cable, line losses will reduce the amplitude of the signal. Enabling VARiable GAIN enables the knob to adjust the gain of the signal so that it fills the graticule. Once the overall amplitude has been set, other relationships within the signal can be verified.

Disabling VARiable GAIN causes the instrument to become calibrated again.

When Variable gain is enabled, the knob changes the gain. Selecting H, V, or Vector allows the knob to return to its normal operation while the instrument is in the offset gain mode. Switching variable gain off and back on allows the knob to once again change the gain.

2. 100%/75% Vectors

This is a Vectorscope function which allows you to select the type of Color Bars, 75% or 100%, for which your instrument is calibrated. If 100% is displayed in the readout, the instrument is calibrated for 100% Color Bars. If nothing is displayed, then the instrument is calibrated for 75% Color Bars.

3. +V Axis (PAL only)

+V Axis is a PAL function and is available only from the PAL mode. When +V Axis is accessed the display of PAL vectors will be overlaid and the result will look more like NTSC vectors.

4. * RESET *

To get back to the factory pre-set mode, select *RESET*. Should the MM-400 become improperly configured, *RESET* will return it to the original factory settings. You may then proceed to re-configure the instrument.

The factory settings are as follows:

Colors: Background - Black, Graticule - Grey, Waveform - Green

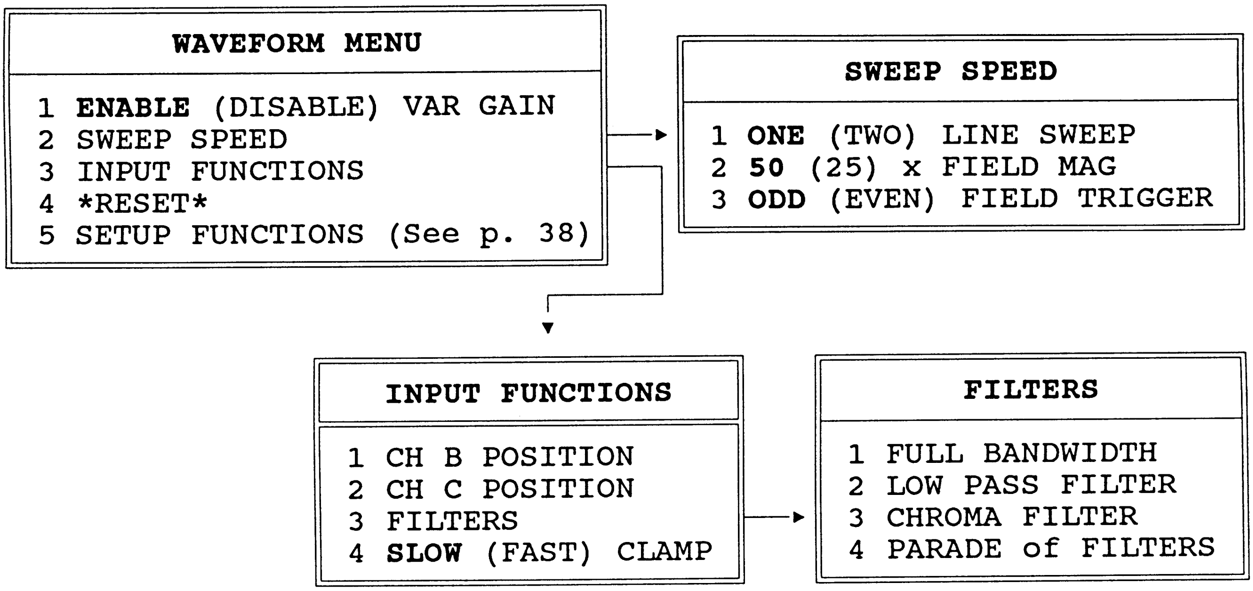
Channel A - Selected
MAGnifier - OFF
REFerence - INTernal
SC/H, Color Frame - Off
Vertical MAG - Blanking
GAIN - Fixed
Clamp - Slow
Picture Mix - Nominal (50%)
Intensity - Nominal
Graticule - Enabled and on top
+V - Off

Selection Mode - Self Cancel
Lock - Crystal
Field Trigger - Even
Sweep - 2H
Timing - Off
Filters - Off
Auto Format - Detect ON
Variable Gain - Off
Persistance - Nominal
Vectors - 75%

5. Setup Functions (See Page 38)

Waveform Menu Overview

If the menu item you've selected contains a **Highlighted** word, a message will appear momentarily confirming your selection.



WAVEFORM MENU

1 **ENABLE** (DISABLE) VAR GAIN
2 SWEEP SPEED
3 INPUT FUNCTIONS
4 *RESET*
5 SETUP FUNCTIONS (See p. 38)

SWEEP SPEED

1 **ONE** (TWO) LINE SWEEP
2 **50** (25) x FIELD MAG
3 **ODD** (EVEN) FIELD TRIGGER

INPUT FUNCTIONS

1 CH B POSITION
2 CH C POSITION
3 FILTERS
4 **SLOW** (FAST) CLAMP

FILTERS

1 FULL BANDWIDTH
2 LOW PASS FILTER
3 CHROMA FILTER
4 PARADE of FILTERS

* Parade of Filters is only active in single channel mode.

Using the Waveform Menu

Pressing the ENTER/EXIT button while in the Waveform Monitor mode yields:

```
WAVEFORM MENU

1 ENABLE (DISABLE) VAR GAIN
2 SWEEP SPEED
3 INPUT FUNCTIONS
4 *RESET*
5 SETUP FUNCTIONS (See p. 38)
```

Description of Waveform Menu:

1. Variable Gain

Variable Gain allows you to temporarily change the gain of the instrument to accommodate signals that do not conform to properly calibrated levels. For example: If a signal travels some distance through coax cable, line losses will reduce the amplitude of the signal. Enabling VARiable GAIN enables the knob to adjust the gain of the signal so that it fills the graticule. Once the overall amplitude has been set, other relationships within the signal can be verified.

Disabling VARiable GAIN causes the instrument to become calibrated again.

When Variable gain is enabled, the knob changes the gain. Selecting H, V, or Vector allows the knob to return to its normal operation while the instrument is in the offset gain mode. Switching variable gain off and back on allows the knob to once again change the gain.

2. Sweep Speed

Selection of 2 SWEEP SPEED yields the following menu:

```
SWEEP SPEED

1 ONE (TWO) LINE SWEEP
2 50 (25) x FIELD MAG
3 ODD (EVEN) FIELD TRIGGER
```

Description of Sweep Speed menu:

1. Line Sweep (One/Two)

This allows you to display one or two horizontal lines of video. The H MAG is changed between 1 µsec/div. (Two Line) and .2 µsec/div. (One Line).

2. Field Mag. (25X/50X)

When in the 2F mode, this allows you to select whether the H MAGnification factor is sync width (50X) or blanking width (25X).

3. Field Trigger (Odd/Even)

This allows you to select which field the display triggers on: ODD (Field 2), or EVEN (Field 1). (The vertical interval at the center of the display will be the opposite field of the one selected.)

3. Input Functions Menu

Selection of 3 INPUT FUNCTIONS yields the following menu:

```
INPUT FUNCTIONS

1 CH B POSITION
2 CH C POSITION
3 FILTERS
4 SLOW (FAST) CLAMP
```

Description of Input Functions menu:

1. CH B Position

Allows the display of Channel B to be positioned vertically when in the multiple input mode.

2. CH C Position

Allows the display of Channel C to be positioned vertically when in the multiple input mode.

3. Filters

The input filters are active in Waveform Monitor only. The filters may be selected through the INPUT FUNCTIONS menu or, with the Quick-keys activated, you may toggle through the filters by pressing button 3. In a single channel mode, the filters will step through: Low-Pass, Chrominance Band-Pass, Parade of Filters (Flat, Low Pass, Chrominance Band Pass), and FLAT. In a multiple channel mode, the parade of filters is not active.

Selection of **3 FILTERS** yields the following menu:

```
        FILTERS

1 FULL BANDWIDTH
2 LOW PASS FILTER
3 CHROMA FILTER
4 PARADE of FILTERS
```

Description of Filters menu:

1. FULL BANDWIDTH (Flat - No filter selected)

Allows viewing of the full bandwidth (5MHz, ±2%).

2. LOW PASS FILTER

Allows viewing of the low frequency luminance component

3. CHROMA FILTER

Allows viewing of the chrominance component.

4. PARADE OF FILTERS

Allows simultaneous viewing of the results of FLAT, LOW PASS, and CHROMINANCE BANDPASS filtering. The selected input is repeated three times across the display with the effects of the filters shown. (See Figure 12.) This feature is only available in single channel modes.

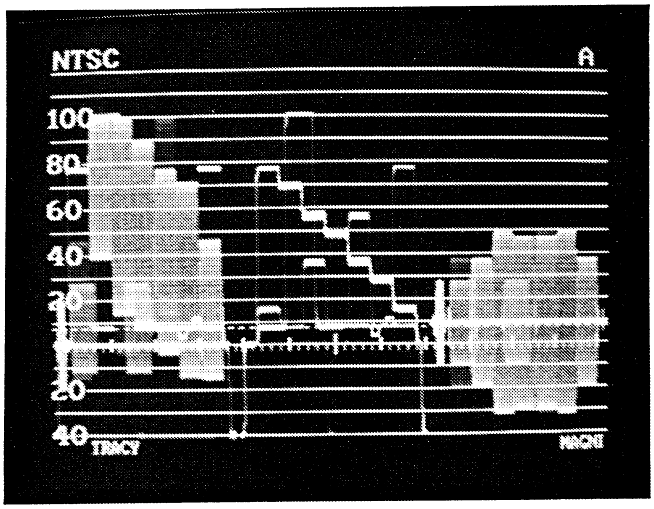


Figure 12 - Parade of Filters Display

4. Clamp (Slow/Fast)

The clamp removes DC level variations present on the input signal. The clamp speed can be selected between SLOW (allows any 50Hz or 60Hz component to pass), or FAST (clamps out the 50HZ or 60Hz component). Each of the three video inputs is individually clamped. This allows any DC level variation to be clamped out even when displaying multiple inputs.

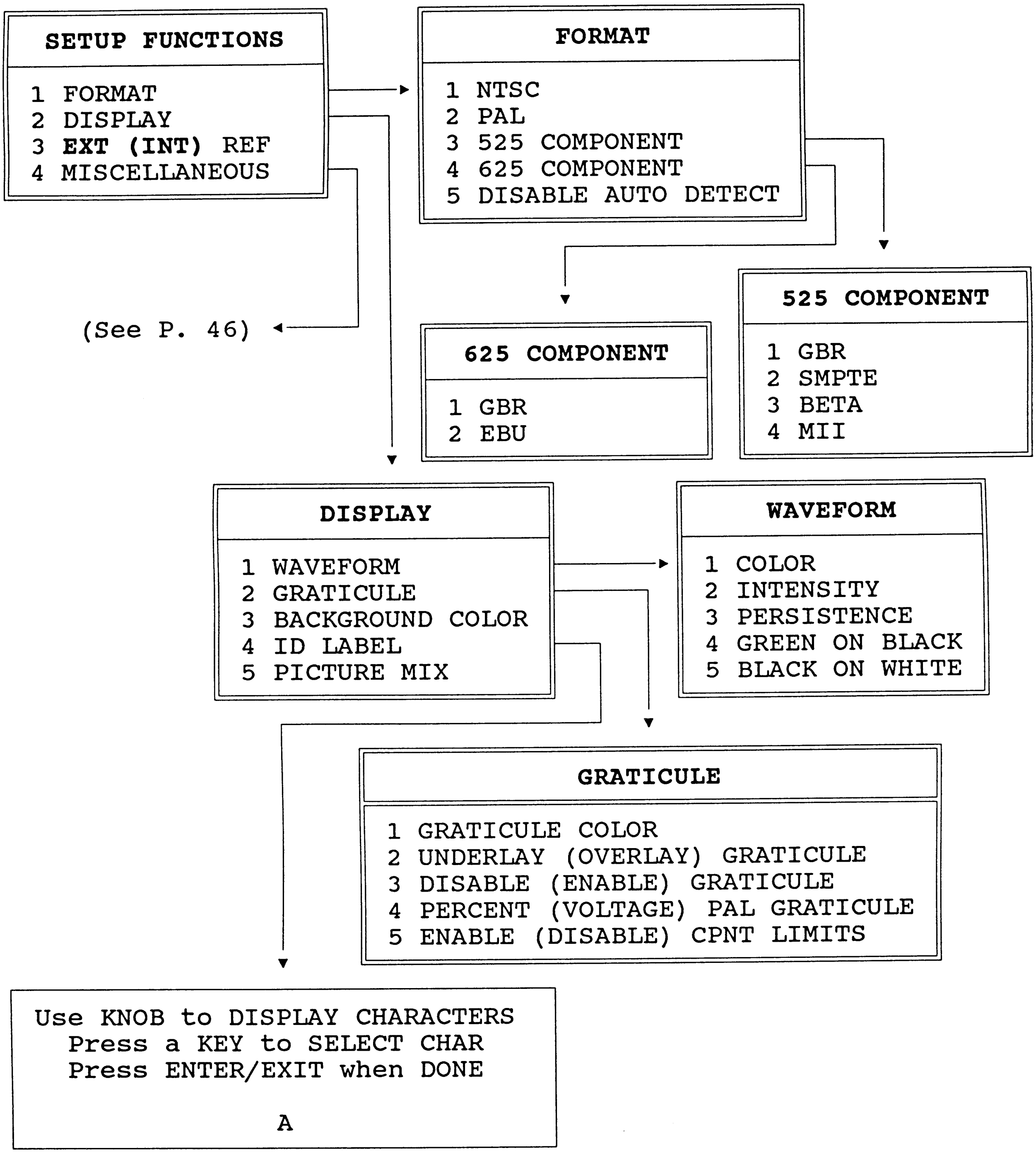
4. *RESET*

To get back to the factory pre-set mode select *RESET*. Should the MM-400 become improperly configured, *RESET* will return it to the original factory settings. You may then proceed to re-configure the instrument.

The factory settings are shown on page 32.

5. Setup Functions (See Page 38)

Setup Functions Menu Overview



Use KNOB to DISPLAY CHARACTERS
Press a KEY to SELECT CHAR
Press ENTER/EXIT when DONE

A

Using the Setup Functions Menu

Selection of 5 SETUP FUNCTIONS yields the following menu:

```
SETUP FUNCTIONS

1 FORMAT
2 DISPLAY
3 EXT (INT) REF
4 MISCELLANEOUS
```

Description of Setup Functions menu:

1. FORMAT

Selecting FORMAT allows you to change the instrument to accommodate the PAL and NTSC composite standards, the 525 and 625 component systems. Within the component systems, the following component formats are accommodated: GBR, SMPTE, BETA, and MII. NOTE: S-Video signals are accommodated by selecting NTSC or PAL standards.

FORMAT LEVEL DIFFERENCES

FORMAT	SYNC TIP	PEAK WHITE
525 CPST (NTSC)	-.286v	+.714V
525 YPBPR (SMPTE)	-.300V	+.700V
525 MII	-.300V	+.700V
525 BETACAM	-.286V	+.714V
525 GBR	-.300V	+.700V
ALL 625 FORMATS	-.300V	+.700V

The instrument has scale markings on the left side of the graticule which provide for the various formats. In NTSC composite and 525 component formats, the graticule has marks at -40 IRE (-.286V) to +100 IRE (+714V). In PAL composite and 626 component formats, the graticule has marks at -0.3 (Volts) to +0.7 (Volts).

Selection for the various systems, standards and formats is made from the FORMAT menus. Selection of FORMAT yields the following:

FORMAT

1 NTSC
2 PAL
3 525 COMPONENT
4 625 COMPONENT
5 DISABLE AUTO DETECT

525 COMPONENT

1 GBR
2 SMPTE
3 BETA
4 MII

625 COMPONENT

1 GBR
2 EBU

Auto Detection

Auto (System) Detect differentiates between 525 and 625 signals being input. You then manually select the Format. If video noise is present, disabling Auto (System) Detect prevents false detections.

2. DISPLAY

The novel display function allows you to setup exactly how the display will appear.

EXAMPLE:

Complaints have been heard in the industry about the colors of the graticule and the waveform on the CRT display of monitoring equipment. The operator's color perception can become distorted by looking at a CRT type waveform monitor then back to a picture monitor during a production. With the MM-400, this is no longer a problem since the display colors: waveform, graticule and background, are now adjustable. Simply set the color of both the graticule and the waveform to white, then set the background color to black (or the background to white and the waveform and graticule to black).

On the other hand, when the display is away from the picture monitors used for production, you may want to select different colors for the waveform, graticle and background either to improve their visibility, or to color-code signals from different sources.

Selection of 2 DISPLAY yields the following menu:

```
DISPLAY

1 WAVEFORM
2 GRATICULE
3 BACKGROUND COLOR
4 ID LABEL
5 PICTURE MIX
```

Description of Display menu:

1. WAVEFORM (or VECTOR)

Selection of **1 WAVEFORM (or VECTOR)** yields the following menu:

```
WAVEFORM

1 COLOR
2 INTENSITY
3 PERSISTENCE
4 GREEN ON BLACK
5 BLACK ON WHITE
```

Description of Waveform menu:

1. COLOR

Displays a menu allowing the waveform (vector) display to be colorized.

2. INTENSITY

The intensity control allows you to increase the intensity of the waveform if you have an area of the signal you wish to examine closely. This controls the apparent light output of a spot on the picture that the waveform crosses. (The circuitry controls the amount of the luminance level of the video output signal by increasing the amount added to the display memory each time the input video signal is at that point.)

This can be set to reach full brightness in one time or up to 64 times.) The brightness changes with MAG and the various sweep speeds are compensated for automatically, allowing the apparent brightness to remain the same between modes.

3. PERSISTENCE

The persistence (or decay) of the displayed waveform is variable through the SETUP, DISPLAY, WAVEFORM, PERSISTENCE menus. Set to maximum (infinite) persistence, "glitches" in the signal that go beyond limits may be captured -- even if this happens only once an hour or once a day. The persistence can also be set so that the Vertical Interval Test Signals (VITS), which have a 100% reference, can faintly be seen in the background. You can then observe the gain characteristics of the video compared to the VITS. A full range of persistence values are available from one-field to infinite which provide many other monitoring options.

4. GREEN ON BLACK

This mode selects a green waveform on a black background.

5. BLACK ON WHITE

This mode selects a black waveform on white background. This gives you a display as it would appear if drawn on paper.

2. Graticule

Selection of **2 GRATICULE** yields the following menu:

GRATICULE
1 GRATICULE COLOR
2 **UNDERLAY** (OVERLAY) GRATICULE
3 **ENABLE** (DISABLE) GRATICULE
4 **PERCENT** (VOLTAGE) PAL GRAT
5 **ENABLE** (DISABLE) CPNT LIMITS

Description of Graticule menu:

1. GRATICULE COLOR

Displays a menu allowing the graticule portion of the display to be colorized.

2. UNDERLAY (OVERLAY) GRATICULE

Selects graticule in front of or behind the waveform.

3. ENABLE (DISABLE) GRATICULE

Switches graticule on and off.

4. PERCENT (VOLTAGE) PAL GRAT

Switches the PAL graticule between 100% full scale and 1 Volt full scale.

5. ENABLE (DISABLE) COMPONENT LIMITS MONITORING

Limit marks occur on the graticule for R-Y and B-Y. The limit marks near the 50 IRE level in both R-Y and B-Y, are equivalent to ± 5°. The boxes near 0 IRE and 100 IRE are equivalent to ± 5%. For each of the bars in the color bar signal, there is one set of limits marks that is equivalent to degrees and one set that is equivalent to percent. This gives the equivalent of vectorscope boxes on a waveform monitor.

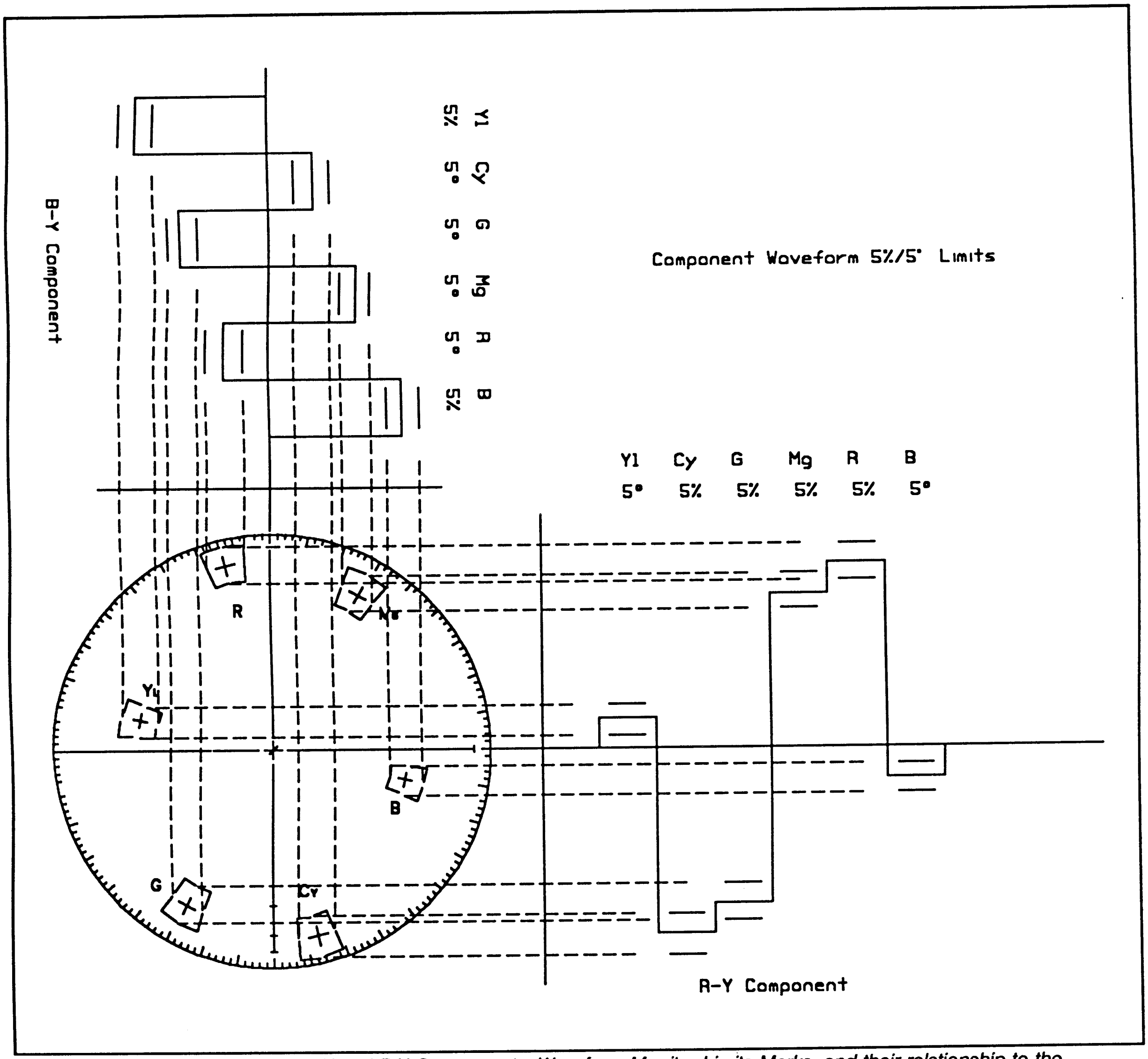


Figure 13 - R-Y and B-Y Components, Waveform Monitor Limits Marks, and their relationship to the Vectorscope Graticule

3. BACKGROUND COLOR

Displays a menu allowing the background portion of the display to be colorized.

4. ID LABEL

A ten-letter (max) label can be placed in the lower-left corner of the picture. The labels can be used to indicate the location of the MM-400, the signal being input, the name of the facility, etc. Selecting ID LABEL, automatically erases the previous label (if present) displaying this screen:

```
Use KNOB to DISPLAY CHARACTERS
  Press a KEY to SELECT CHAR
  Press ENTER when DONE


              A
```

Follow the directions given on the screen to create a new label. (Selection of the tenth letter will also return the instrument to the waveform mode.)

5. Picture Mix

The output from the PICTURE connector on the rear panel may be switched between Waveform (or Vector) only, Picture/Waveform (or Vector) mix, or picture only. This allows you to superimpose the waveform over the picture if you desire. The menus allow you to select the ratio (mix level) between Waveform and Picture.

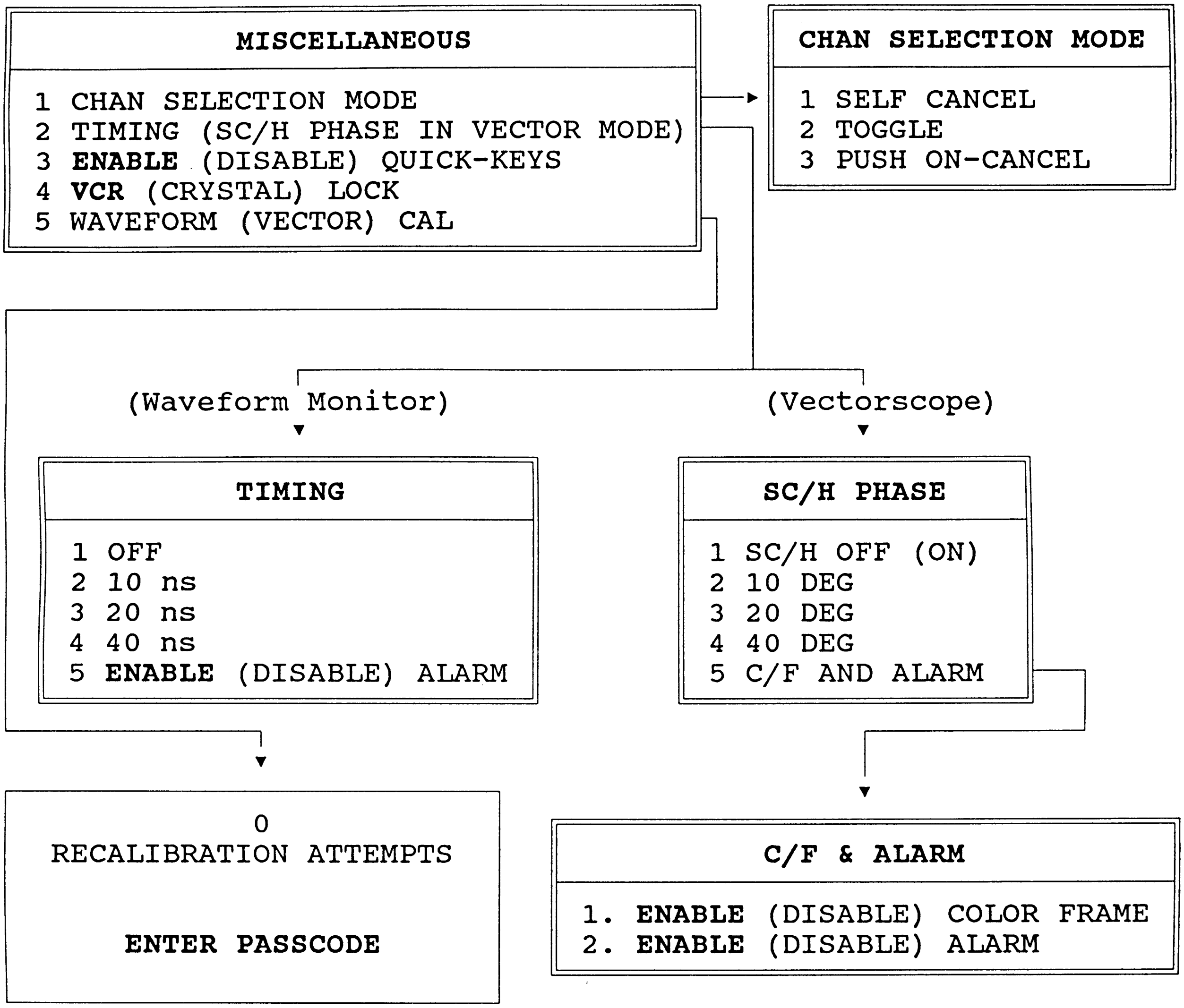
3. Reference, Internal/External

The instrument is provided with an external reference input to provide a timing reference when displaying more than one channel, or when comparing timing of one input to another. The instrument automatically switches to EXTernal REFerence when multiple channels are enabled.

Selecting EXTernal REFerence keeps the timing referenced to this input even in the single channel modes. This allows timing measurements between input signals.

NOTE >>> Sync must be present on an input or EXTernal REFerence enabled in order for the instrument to provide lock for proper display.

4. Miscellaneous



NOTE >>> The passcode is found on P52. Observe the cautions given there. Additional information is found in the Service Manual.

Using the Miscellaneous Menus

Selecting 4 **Miscellaneous** from the Setup Functions menu yields the following:

```
              MISCELLANEOUS

1 CHAN SELECTION MODE
2 TIMING (SC/H PHASE IN VECTOR MODE)
3 ENABLE (DISABLE) QUICK-KEYS
4 VCR (CRYSTAL) LOCK
5 WAVEFORM (VECTOR) CAL
```

Description of Miscellaneous menu:

1. Channel Selection Mode

There are three channel selection modes. These modes allow tailoring the method of input selection to best suit your needs.

Selection of CHAN SELECTION MODE yields the following menu:

```
 CHAN SELECTION MODE

1 SELF CANCEL
2 TOGGLE
3 PUSH ON-CANCEL
```

Description of CHAN SELECTION MODE menu:

1. SELF-CANCEL

Allows only one signal to be viewed at a time.

2. TOGGLE

This Push-on/Push-off method allows the operator to select any (or all) inputs in the manner used by oscilloscopes.

3. PUSH ON-CANCEL

Pushing the input button turns that input on while leaving on any other input already selected. A second push of that input button cancels the other inputs. This proves to be the fastest operation because you only need to push the button of the input you want to view.

2. Timing and SC/H Phase

Depending upon whether you are in Waveform or Vector modes when you select Miscellaneous, you will see different menus.

1. If you are in the Waveform mode <u>and</u> Component, you will see **2 TIMING** in the Miscellaneous menu.
2. If you are in the Waveform mode but in Composite you will see **2 TIMING**, however, the function will be inoperable.
3. If you are in the Vectorscope mode you will see **2 SC/H PHASE** in the Miscellaneous menu.

The Timing menu is described below. The SC/H Phase menu is described following.

Timing (Waveform/Component Mode)

Selecting **2 TIMING** yields the following menu:

```
              TIMING

1 OFF
2 10 ns
3 20 ns
4 40 ns
5 ENABLE (DISABLE) ALARM
```

1. OFF

Disables the monitoring of Timing.

2. 10 ns
3. 20 ns
4. 40 ns

The component timing monitoring is enabled by selecting limits: 10 ns, 20 ns or 40 ns. The timing of the green-to-magenta transition of color bars is monitored to be within the limit selected between CH A (Y, or G), and CH B (B-Y or B) or CH A and CH C (R-Y or R).

****	****	will be displayed if color bars are not found.
B ADV	R ADV	will be displayed if CH B and C are advanced relative to CH A.
B DLY	R DLY	will be displayed if CH B and C are delayed relative to CH A.

NOTE >>> The input signal must be a three channel component color bars signal in the format selected. The monitoring mode must be three channel horizontal parade. "*****" will appear if the signal does not have an appropriate Green-Magenta transition on the third channel.

Ten seconds will elapse before the indication is reliable. Variable GAIN, MAG, 2H stops the timing monitor. An alarm drive can be set to activate when the limits are exceeded.

SC/H Phase (Vector Mode)

Selecting **2 SC/H PHASE** yields the following menu:

```
SC/H PHASE

1 OFF
2 10 DEG
3 20 DEG
4 40 DEG
5 C/F AND ALARM  --->
```

```
C/F & ALARM

1. ENABLE (DISABLE) COLOR FRAME
2. ENABLE (DISABLE) ALARM
```

1. OFF

Disables the monitoring of SC/H Phase.

2. 10 DEG
3. 20 DEG
4. 40 DEG

In the composite vector mode, the monitoring of SC/H (SubCarrier to Horizontal phase) is enabled by selecting Monitoring Limits, 10, 20, or 40 degrees. SC/H Phase is active in the single channel mode only and will automatically be disabled if more than one channel is selected.

"SC/H OK" will be displayed if SC/H is within the limits established.

"SC/H HI" indicates that subcarrier is advanced beyond the selected limits relative to horizontal sync.

"SC/H LO" indicates subcarrier is delayed beyond the limits relative to horizontal sync.

An alarm drive can be set to activate when the limits are exceeded. SC/H phase lock takes 3-5 seconds nominally, up to 20 seconds for an initial lock.

NOTE >>> NTSC signals must meet RS-170A. PAL signals must have a correct 8-field sequence with burst harmonically related to sync and with at least 1 microsecond of "front porch".

SC/H (and color framing) are not monitored with multiple channels active or in MAG or variable GAIN modes. Any one of channels A, B or C may have SC/H monitored when INTernally REFerenced.

5. C/F (Color Frame) and Alarm

Color Frame

The Color Frame of the selected signal, CH A or CH B, is compared to the Color Frame of the signal on CH C. To enable the Color Frame detection mode, select: the single-channel composite mode, CH A or CH B, SC/H, and Color Frame. When color frame is enabled, REFerence toggles Color Frame on (EXT) and off (INT).

To operate correctly, the signal on channel C must be looped-through to the reference input and terminated in 75Ω. In addition, the signal on CH C must be timed within +/- 500 nanoseconds of CH A (or B) in order for color frame to be determined.

If the above conditions are not met, "C/F ERR" will be displayed. If these conditions are met and color frame is correct, the display will read "C/F OK".

NOTE >>> The SC/H Phase indicated is always the SC/H phase of the displayed signal even in the Color Frame mode. It is not the SC/H Phase of the input signal relative to the CH C input signal.

Color Frame detection is disabled when SC/H phase is disabled or when REFerence is set to INTernal.

Alarm

The alarm enabled allows an output from the rear panel to give warning if timing or SC/H phase has exceeded the set limits.

The alarm signal can drive the remote of a switcher so that it will change from the normal switcher output to the waveform output when there is an alarm condition.

3. Quick-Keys (Enable/Disable)

Quick-keys allow the operator to select certain often-used functions directly from the Control Panel by simply selecting the appropriate numbered button of the feature you want to change. (Note however that Quick-Keys are not operational when a menu is selected.)

To help inexperienced operators, Quick-keys may be disabled to insure that control access is only through the menu structure.

The Quick-key functions differ between models and are as follows:

Waveform Monitor Mode	**Vectorscope Mode**
1. Var Gain: Enable/Disable	Var Gain: Enable/Disable
2. 2H/1H (in 2H), Fld 1/Fld 2 (in 2F)	75%/100% Vectors
3. Filters	Normal/+V (PAL)
4. Picture Out: Waveform (Vec) Only, Picture/Waveform Mix, Picture Only	Picture Out: Waveform Only, Picture/Waveform Mix, Picture Only

NOTE >>> Selections made with Quick-Keys will not be saved upon power-down. To save these selections, the changes must be made through the menus.

4. Lock (VCR/Crystal)

The Waveform Monitor allows the selection of crystal lock or VCR lock. If a signal being viewed is stable, you should have the crystal lock enabled so that you will have the sharpest display of the waveform. However, when monitoring a VCR output where jitter is present, you should switch the instrument to the VCR oscillator mode.

The VCR oscillator will work on a stable signal, however, there may some slight increase in jitter.

5. Calibration (Waveform/Vector)

If you select this, the display will ask you for the four-digit access code. Each time you enter the access code, the Recalibration Attempts log will increase by one.

WARNING: Refer calibration to a qualified technician. There is ample opportunity to lose instrument calibration by improperly using the calibration menus, therefore -- **Enter the CALIBRATION mode only if you intend, and are qualified to, re-calibrate the instrument.**

IMPORTANT: *RESET* will not recover the calibration.

(The access code is 3254.)

FOR THOSE OF YOU WHO'LL LOOK ANYWAY, PLEASE NOTE: If you accidently select an adjustment, **DO NOT MOVE THE KNOB!** Moving the knob changes the adjustment's calibration.

Worse yet - even if Auto-Select has not been disabled - if you select an adjustment in a format (standard) not being input to the instrument, the instrument will automatically switch to that format (standard) and **the display will become unlocked and unusable.... meaning....you won't be able to see the menus anymore.**

To recover the unstable display, do the following: push ENTER/EXIT,ENTER/EXIT, **5**, **1**, then **1** if your input is NTSC, or **2** if your input is PAL.)

NOTE >>> If format (standard) AUTO DETECT is enabled, the format will automatically revert to the correct format once a signal is input.

Most calibration adjustments are Auto-Calibrating. To Auto-Calibrate, simply connect a Magni Signal Creator to the input(s) of MM-400 and generate the special test signals: PAL AUTOCAL or NTSC AUTOCAL. Select Automatic Calibrate from the CAL menu, and, MM-400 does the rest. The Auto-Calibration feature helps guarantee optimum performance from all your equipment under test and reduces the possibility of extended down time. See the Service Manual for more information.

A few adjustments remain: R-Y & B-Y Subcarrier, SC/H Phase, Chroma Phase, and Output Level. The adjustments are made by using the Manual Calibration procedure without opening the instrument covers.

NOTE >>> If you experience difficulty with the Autocal mode, try the Manual Calibration adjustments mentioned above before returning the instrument for service.

Connector Pinout Diagrams

Aux. Connector

1. Picture Video (75 Ohms)
2. Reserved
3. Audio Alarm
4. +12
5. GND
6. GND

Remote Input from Computer (6-pin Phone)

1. TXD (output from MM to computer RXD)
2. RXD (input to MM to computer TXD)
5. GND (to computer logic ground)

(All other pins must be un-connected)

4. Application Notes

Five application notes are included in this section. These notes are intended to help you to more fully understand video. The five application notes are as follows:

Application Note 1 - Brightness and Contrast

This application note describes the most fundamental principle of video ... the relationship between contrast and brightness. Although simple on the surface, how they relate to each other, and how you handle errors that can occur between them, can profoundly effect your video.

Application Note 2 - NTSC Video

This application note describes the basics of the NTSC video signal, discusses the various components of the signal and their uses, and describes the evolution of NTSC video from Black and White to Color. (Some references are made to the PAL composite video system as well.)

Application Note 3 - The Waveform Monitor

This application note describes the uses and features of the Waveform Monitor. Included are examples of how to apply signals to system components, then observe the results on a Waveform Monitor.

Application Note 4 - The Vectorscope

This application note describes the uses and features of the Vectorscope. Included are examples of how to apply signals to system components, then observe the results on a Vectorscope.

Application Note 5 - The Signal Generator

This application note emphasizes the use of a Signal Generator and how the test signal patterns may be used to verify proper operation of your video equipment. This information can help you quickly identify which piece of equipment in a system is faulty when something goes wrong.

Application Note 6 - Installation Suggestions

This application note describes some novel and highly useful ways to use MM-400. Many other clever uses will no doubt be developed by customers, but this note provides a starting point.

Application Note 1 - Brightness and Contrast

The relationship between brightness and contrast is often misunderstood. It is important that you know how they relate as you create video productions because brightness (known as pedestal in video) and contrast (known as gain) errors between multiple tape generations, for example, are cumulative. Which means, they get worse with each generation. Furthermore, they cannot be completely corrected after-the-fact even with the most sophisticated video correction equipment.

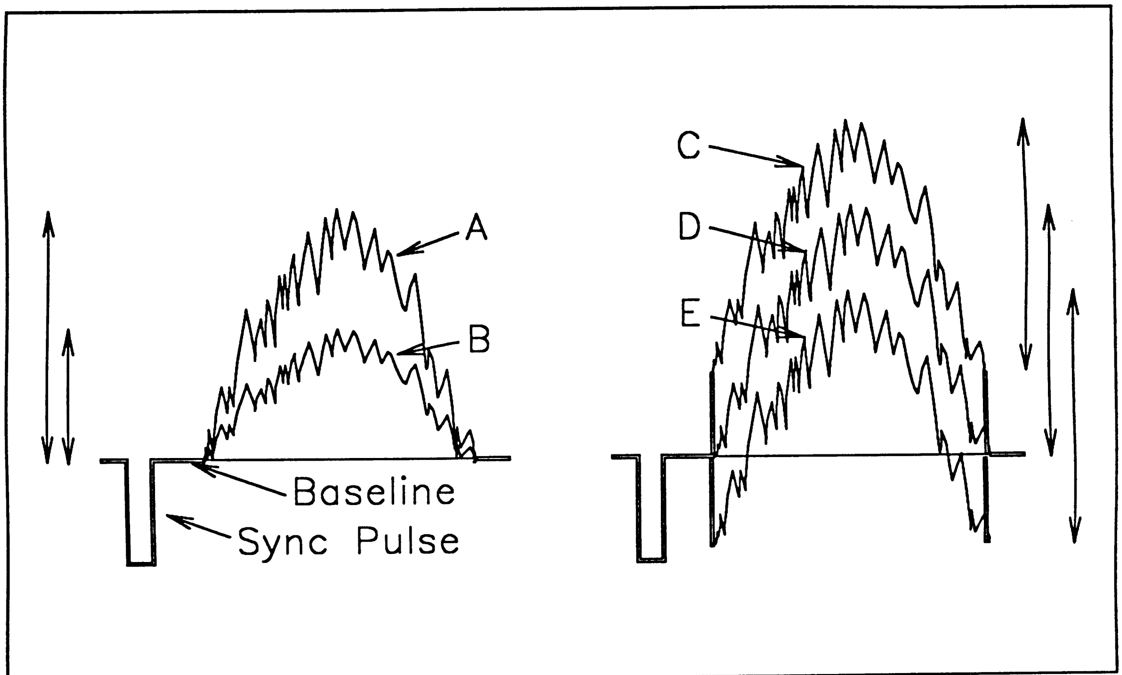


Figure 14 - Waveforms representing changes in Contrast/Gain (Left) and Brightness/Pedestal (Right)

Contrast/Gain

Waveform (A) represents a normal contrast picture while waveform (B) represents a low contrast (grey and faded) picture. Note that the overall amplitude of the signal above the baseline is the only thing that changed.

Results of Contrast/Gain Errors

When Waveform (B) is recorded, the result will be a noisier picture since the lost gain will have to be compensated for by amplifying the signal at the time of playback ... which amplifies the videotape background noise along with the video. (This can add extra "grain" or "snow" to your picture.)

Brightness/Pedestal

Waveform (D) represents a normal brightness picture, while waveform (C) represents a picture with too high a brightness (pedestal) level. Waveform (E) represents a picture that has too low a brightness level. Note that the shapes of the waveforms are the same, however, the beginning and ending points of the waveforms occur at different points relative to the baseline.

This is very important since everything in video is referenced to the baseline of the waveform. What is too far above or below the baseline is either "clipped" or otherwise compressed by video circuitry.

Results of Brightness/Pedestal Errors

Waveform (C) will tend to overload the video circuitry of a VCR and can result in "white clipping". "White clipping" is the result of all light grey through white areas of the signal being clipped by overloaded video circuits in the VCR rendering them all the same shade ... white. This results in a complete loss of picture detail in all those areas. No amount of adjustment after "white clipping" has occurred can cause these lighter shades of grey to return.

Additionally, unless the VCR's automatic circuitry compensates properly for the condition, when the recording is played-back, not only will white clipping be evident, but the darker shades in the video will appear grey and washed-out as well.

Waveform (E) may have all the video below the baseline clipped (called "black clipping") by VCR circuitry upon recording. This results in the darker shades of grey becoming black. Again, no amount of adjustment after "black clipping" has occurred can cause these darker shades of grey to return. (The effect is hard to describe but you'll know it when you see it.)

Summary

Add to this (basically a monochrome discussion) the complication of color, and realizing that the errors described above also apply to it, you can see what you're up against. For example, when clipping occurs to the color portion of your video, complex changes can take place. You can expect to see: deep colors change to lighter colors, random changes in the hue of certain colors, and/or increased chroma noise (or "colored snow") can occur. You can see from this how important it is to know everything about every stage of your video production.

Difficult? ... not really. The MM-400 is the instrument to accurately observe your video at every step, detect problems, and allow you to correct or get them corrected as soon they occur.

Application Note 2 - NTSC Video

Introduction

Confusion surrounds the word "video" as it is being used today. Any number of different video systems and applications use the word "video" and in the majority of these cases, the "video" may have no resemblance whatever to NTSC video (our subject here) other than that brightness is represented by voltage.

This is particularly true when the word "video" turns up as a computer graphics term. "Video" in this case represents the output the computer sends to its monitor. This output is a three-wire signal: Red, Green and Blue (RGB), which carry color and brightness (luminance) for the computer's display.

NTSC video, on the other hand, is a one-wire composite signal with luminance and color signals combined. Additionally, NTSC video differs from computer video in the number of scan lines needed to complete a picture (frame), the scanning rate, and that the NTSC picture is interlace scanned rather than sequentially scanned. (The technical differences between the systems will be fully explained in the section on computer video.)

Video Levels

In the NTSC system, the amplitude (voltage) of the signal determines the brightness. An amplitude of 714 millivolts (or 1000ths of a Volt) is 100% or white level (referred to as "peak white"), 53.6mV is black level (referred to as setup), and 0.0mV is the blanking level.

The brightness levels between peak white and blanking are numbered from 0 to 100. These numbers are called IRE units, with 100 IRE representing peak white, 7.5 IRE representing black, and 0 IRE representing blanking.

The brightness control on your picture monitor moves both black and white levels up and down to make the whole picture brighter or darker. The contrast control expands or shrinks the range between the black and white levels.

Figures 15 and 16 show waveform monitor and picture monitor displays of a standard test signal (color bars) so you can visualize the relationships between brightness (seen on the picture monitor) and amplitude (displayed on the waveform monitor). The left side of the waveform monitor represents the amplitude of the signal found at the left side of the picture monitor.

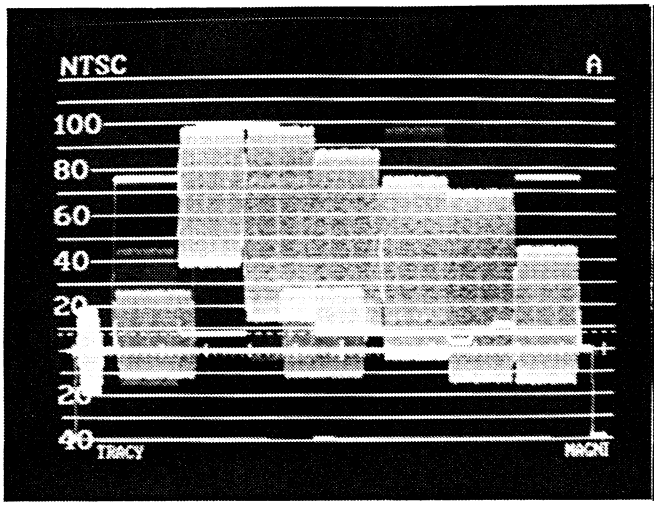


Figure 15 *- A waveform monitor displaying one line of a color bar signal.*

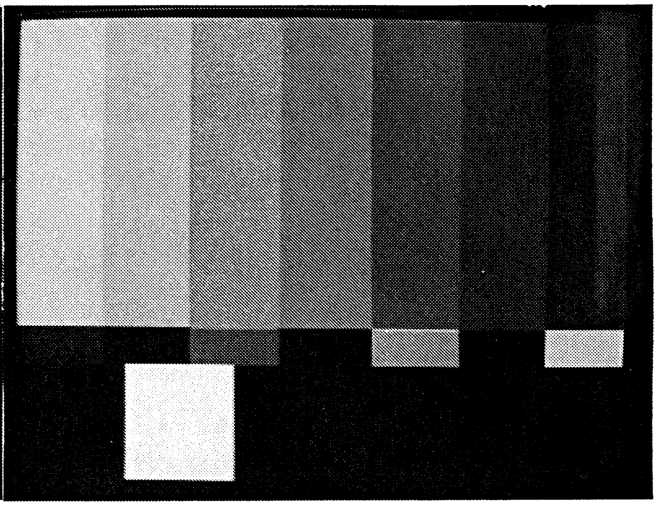


Figure 16 *- A picture monitor display of a color bar signal.*

Sync

Synchronization pulses (abbreviated sync pulses or simply sync) provide the timing information for all equipment in the video system. Sync pulses time the start of horizontal sweep, vertical sweep, and retrace in picture monitors. Sync pulses allow video equipment to genlock (synchronize), and VCR (VTR) servos to lock to incoming video producing output signals timed to the input. Sync pulses are absolutely essential in television and yet, because sync pulses take place beyond the edges of the picture, they are not seen -- except on a waveform monitor. (See Application Note 3 - The Waveform Monitor.)

The sync pulses within the NTSC video signal are negative-going (below blanking) -286mV or -40 IRE (See next page). The total signal level of NTSC video is therefore:

714mV plus 286mV = 1000mV or 1.00 Volt peak-to-peak.

In IRE terms:

100 IRE plus 40 IRE = 140 IRE peak-to-peak.

NTSC VIDEO AND SYNC AMPLITUDE RELATIONSHIPS

Signal Amplitude	%	IRE	Description
714 mV	100%	100 IRE	White Level or Peak White
			▲ Light Gray
			All Shades of Gray
			▼ Dark Gray
53.5 mV	0%	7.5 IRE	Black Level or Setup
0.0 mV	--	0 IRE	Blanking
-286 mV	--	-40 IRE	Sync Tip

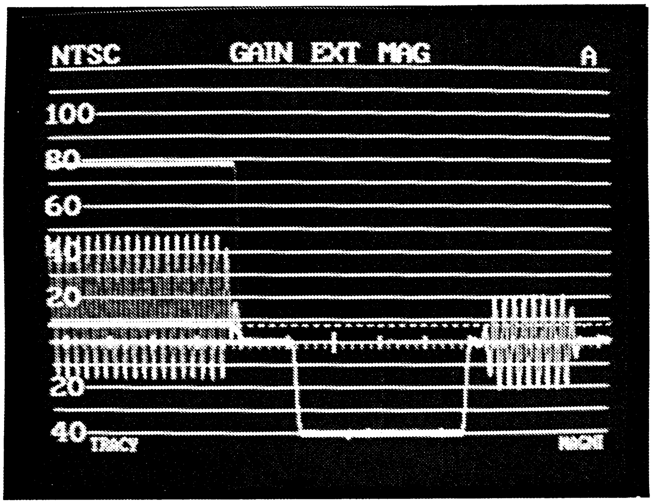


Figure 17 - Magnified Waveform showing Horizontal Sync and Burst.

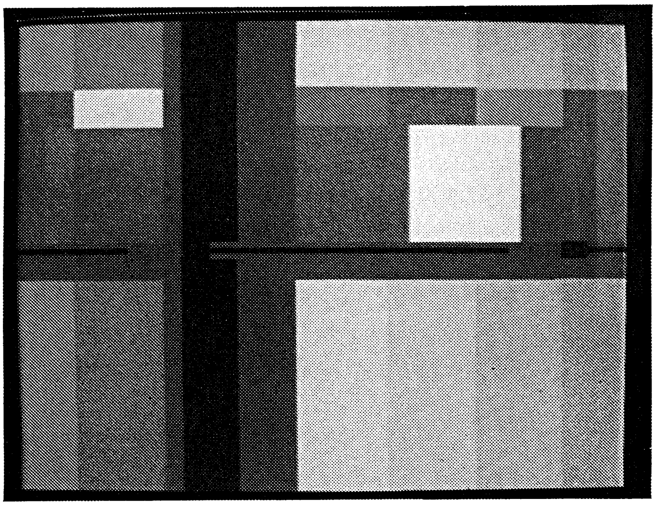


Figure 18 - Picture Monitor Display Offset in Time to Show Horizontal and Vertical Sync (Black areas)

Video Termination

Video systems are designed for 75 Ohm cables with 75 Ohm termination. Many of the inputs on video equipment are "loop-thru" allowing the video to be looped through from one unit to another connecting them in series. The output of the last piece of equipment in the series signal path must be terminated in 75 Ohms (see Figure 19). Some units have a terminating switch in the output loop-thru connector so that if no cable is connected to the output, the loop-thru is automatically terminated. If 75 Ohm cable is not used, or the signal path is incorrectly terminated, amplitude errors and/or video degradation in the form of ringing (ghosts) caused by internal electronic reflections within the cable will occur.

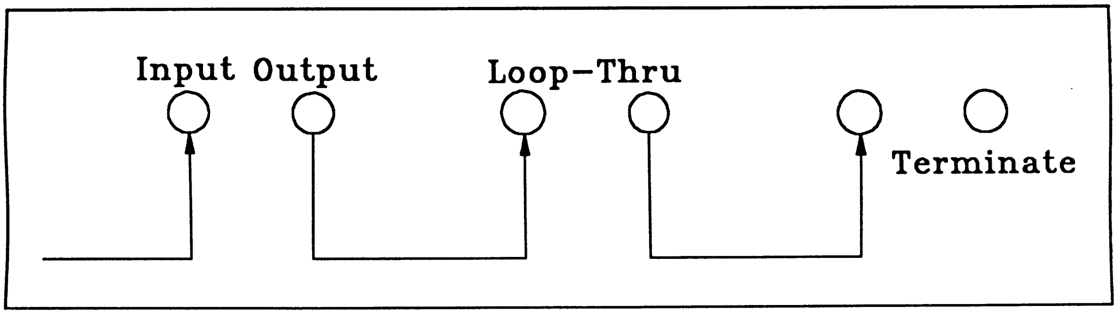


Figure 19 *- Termination Diagram (Shows several designations for loop-thru connections)*

FRAMES, FIELDS, LINES and SYNC

Video is composed of various elements that occur within a carefully defined time framework. Let's begin with the easiest to understand -- the frame.

Frame

A frame is simply a "complete" picture. Video frames (and movie frames as well) create the illusion of motion based upon a single physiological principle -- persistence-of-vision.

Persistence-of-vision allows the eye (and mind) to be fooled into believing that when individual pictures are changed fast enough to another slightly different still picture, the change is not abrupt, but continuous. That was a longish way of saying: change frames fast enough and slight differences between the frames are made to appear as smooth motion.

In video, a frame is not actually a picture, but a continuous stream of electronic information that forms a picture. The information is scanned onto the inside surface of your picture tube by an electron beam. After 1/30 of a second a frame (picture) is completed and the process begins again to form the next frame. Every 1/30th of second a new picture is completed giving a frame rate of 30 fps (Frames Per Second). (In the PAL system, the frame rate is 25 fps)

Lines and Fields

Each frame of video is made up of 525 lines which are scanned inside your picture tube to create the image. The 525 line frame is made up of two interlaced 262½ line fields called field 1 (even) and field 2 (odd).

Field 1 is scanned onto the picture tube beginning at the left side, from top to bottom. Then field 2 is scanned, again, from top to bottom, except that field 2 starts at the center of the screen. This places the scan of field 2 half-way between the lines of field 1, forming an "interlaced" scan and one frame of NTSC video (See Figure 20).

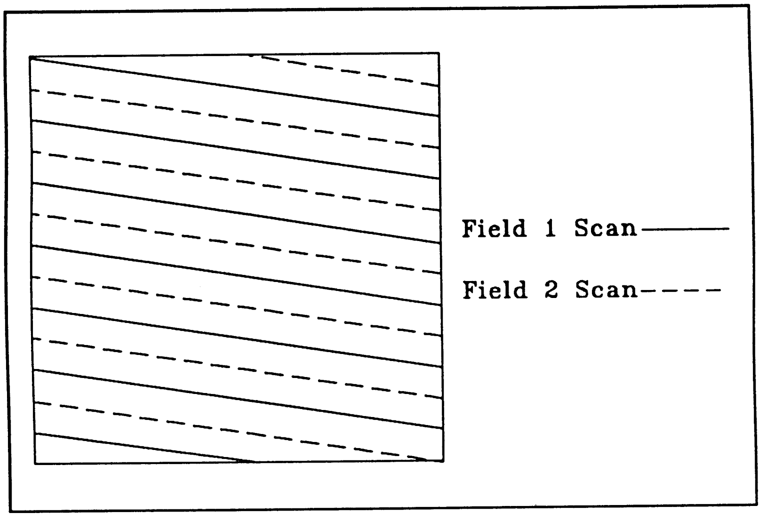


Figure 20 *- Interlaced Scan*

Although not a complex process, interlaced scan significantly reduces flicker and motion artifacts in fast-moving scenes by giving you an **equivalent** frame rate of 60 pictures per second (60 fields per second) -- without increasing transmission bandwidth. All broadcast television standards employ the interlaced scan technique.

(Similarly, motion picture film runs at 24 frames per second. Yet to reduce flicker, each frame is projected twice, resulting in the audience seeing an equivalent frame rate of 48 frames per second.)

Some numbers:

As mentioned, the field rate is 60 Fields Per Second or, one field completed each 1/60th second. Therefore, two 1/60th of a second fields = one 1/30th of a second frame, each frame defining a complete black and white picture.

Sync

Something must coordinate the scanning electron beam within your TV's picture tube so that it puts each line and field exactly where it should be in your picture. The job of timing all of this falls to two types of sync (synchronizing) pulses, horizontal sync pulses (or line sync) and vertical sync pulses (or field sync).

Horizontal Sync

The horizontal sync pulse is a negative going pulse which occurs each line to tell the electron beam to stop scanning that particular line, go back to the left side of the screen (begin horizontal re-trace), and start scanning the next line.

Vertical Sync

The vertical sync pulse is actually a group of negative-going pulses that occur at the beginning of each field. A set of six approximately ½-line wide pulses called serrations form what your TV set and other equipment detect as the vertical sync pulse. Vertical sync pulses tell the electron beam to stop scanning that field, go to the top of the screen (begin vertical re-trace), and start scanning the next field.

Field sequence

The sync pulses also define the field sequence (field 1 and field 2) which is determined by where the serrations start. If the serrations start at the beginning of the line, it is defined as field 1; if they start half-way through the line, it is defined as field 2 (see Figures 21 and 22).

Some more numbers:

Fields are scanned at a sixty (actually 59.94) Hertz rate, while frames are scanned at a thirty (actually 29.97) Hertz rate, or: two 60Hz fields = one 30Hz frame. The individual lines of the field and frame are scanned at a 15,734.26 Hertz rate and have a duration of 63.56 microseconds (µs). Blanking occurs before, during and after sync and keeps the returning (re-tracing) electron beam within the display from being visible as it returns to the start the next line or field. The horizontal blanking width is approximately 11µs with the horizontal sync pulse being 4.7µs. The vertical blanking width is 21 lines including the vertical sync.

The complete vertical sync is formed by 6 serration pulses and 12 equalizing pulses that are twice the rate of horizontal sync. (The serration pulses are approximately 27μsec. wide and the equalizing pulses are approximately 2.35μsec. wide.) Six of the equalizing pulses occur before the serrations, and six after.

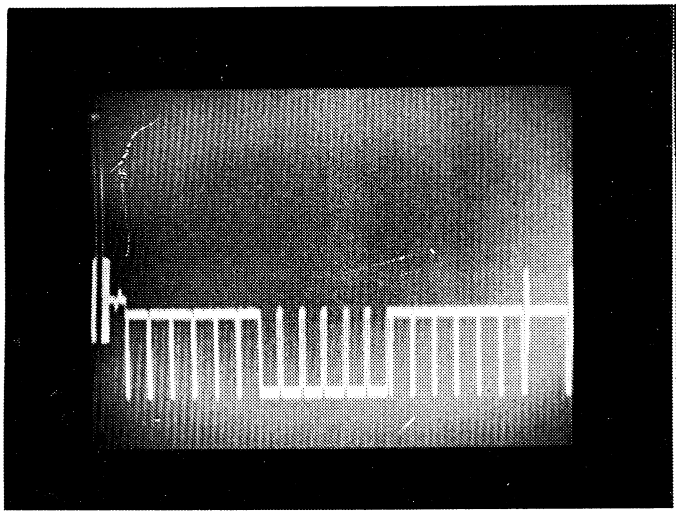


***Figure 21** - Vert. Sync, Field 1*

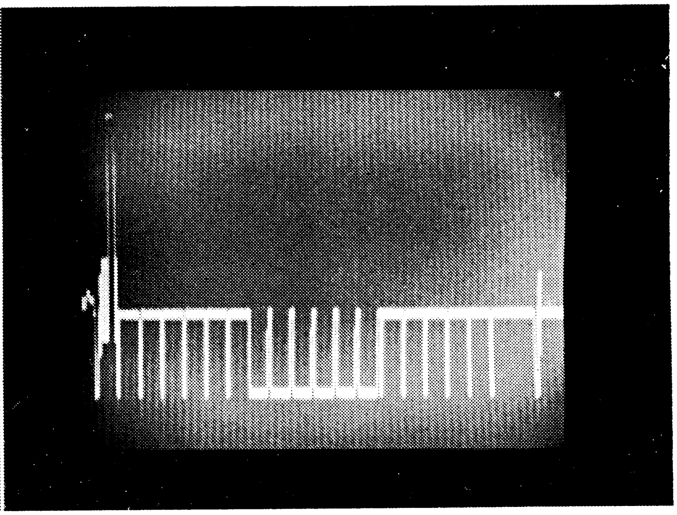


***Figure 22** - Vert. Sync, Field 2*

In Figure 21, Field 1 shows a full line of video present before the equalizing pulses and 1/2 line after. Note that in Figure 22 however, Field 2 shows 1/2 line of video occurring before the equalizing pulses and a full line after.

Color

What we have discussed so far is (approximately) the black and white (monochrome) television system which dates from the 1930s. In the early 1950s, a color television transmission system for the U.S. was adopted by the F.C.C. The primary design requirement was that the system be compatible with the monochrome TV sets and transmitter bandwidths already in use. The new system, called NTSC for the National Television Systems Committee that proposed it, with few exceptions, remains in use unchanged to this day.

In the NTSC system, color information is appended to the original monochrome signal by the addition of a phase and amplitude modulated 3.58 MHz (actually 3.579545 MHz) subcarrier. The color subcarrier frequency was chosen to be a 227.5 multiple of the horizontal line frequency (15,734.26 Hz) so that when color is present, the positive peaks of the subcarrier on one horizontal line will occur next to the negative peaks on the next horizontal line, and be averaged out.

This technique helps satisfy the compatibly design criterion since, black and white displays are (mainly) not adversely affected by the presence of color.

A 3.58 MHz reference burst is put into the blanking just after horizontal sync to lock circuitry in color TV sets permitting them to recover the color phase information (see Figure 23, left side between -20 and 20 IRE). The reference burst is 40 IRE pk-pk (286mV) in amplitude and is nine cycles of the reference subcarrier. A total of 227.5 cycles of the modulated subcarrier occur throughout each horizontal line carrying the color information.

The amplitude of the subcarrier modulation determines the saturation (intensity) of the color. The phase of the modulation (in reference to burst) determines the hue of the color. Subcarrier modulation is not present when there is no color, and increases in amplitude as the saturation of color increases.

The luminance (Y), and the two axes of chrominance B-Y and R-Y (originally -I and Q axes) are typically derived by matrix from the RGB outputs of the camera. The B-Y and R-Y signals modulate the subcarrier on axes that are 90° apart. This process called encoding produces a phase and amplitude modulated color subcarrier which is added to the luminance (Y) channel to form the composite NTSC signal.

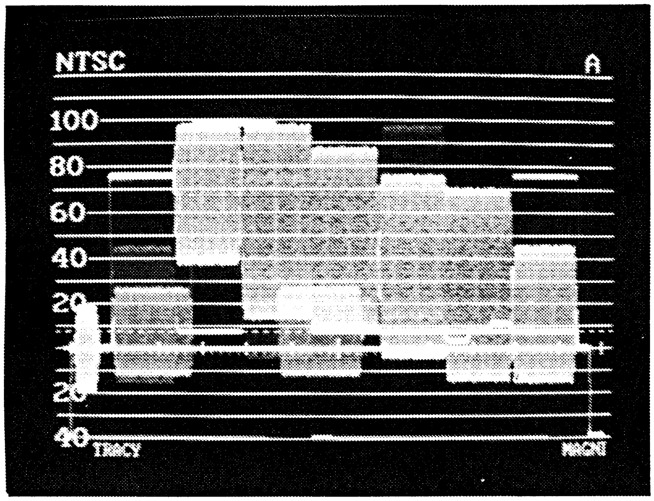


Figure 23 - *Waveform Display of Modulation on Color Bars and Reference Burst*

Color Frame

The subcarrier frequency is such that on each line, the phase of burst relative to sync changes by 180 degrees. Since there are an odd number of lines in a frame (525), there will be a 180 degree phase difference between one frame and the next. Two frames (four fields or 1050 lines) are required before the burst-to-sync phase repeats itself, thereby completing one color frame. One complete color frame is therefore a four-field sequence. (Color frame synchronization is important in switching and editing systems to avoid "picture shift" at transition and edit points.)

NOTE >>> Different television systems have different field sequences (color frames). PAL for example, has an eight-field sequence.

Genlock

Horizontal and vertical sync pulses in the video signal, as well as synchronizing display monitors, allow circuitry in certain pieces of equipment to electronically lock to one another. This technique, called genlocking, allows video equipment to be synchronized. For example, genlocking is necessarily performed in order for signals from multiple sources to be processed together in a switcher.

The horizontal sync pulse, which is an approximately 4.7 μsec negative going pulse, allows equipment to (gen)lock horizontally. If burst is not present, most equipment will lock to this signal. If burst is present, genlocking to both horizontal sync and burst will produce a more stable horizontal lock.

Vertical lock is typically accomplished by detecting the six serration pulses, which occur during vertical blanking. The determination of Field 1 and Field 2 is done by detecting whether the first vertical sync pulse is timed to the horizontal sync pulse or is a half-line off.

COLOR LOCK

When burst is present, the genlock circuitry can improve the stability and position of the horizontal lock. The phase of the locked burst relative to the leading edge of sync determines the subcarrier to horizontal (SC/H) phase. When SC/H Phase is within limits, the 4 Fields of the color frame can be matched. Once matched, horizontal shifts will not occur when you transition between different sources in your switcher or editing system.

The phase of burst relative to horizontal sync allows equipment to match the 4 fields of a color frame. Burst is also used to lock the subcarrier regenerator for detecting colors.

SC/H PHASE

Certain instruments can detect SC/H phase errors (SubCarrier to Horizontal phase) and can display this phase offset to the operator. The closer this phase offset is to zero, the more likely the color-frame detection circuitry in processing equipment is going to be accurate. (If the SC/H phase is off by more than 40 degrees, the color-frame detection is not likely to be accurate and might, for example, result in incorrect edits.)

VCR Formats

An essential piece of equipment in video production is the Video Tape (Cassette) Recorder -- the VTR or VCR. There are different formats for Video Tape Recorders. For example, some record composite video only and some record composite and/or component video.

NON-BROADCAST COMPOSITE RECORDERS

Consumer-grade VCRs (VHS, etc.) input and output composite video. However, in order to achieve long record/play times, these VCRs do not record the full bandwidth of the NTSC composite signal. Additionally, in order to record color, they use a "color-under" recording technique which separates the color information from the luminance (or brightness) and records it at a lower frequency, thereby using less bandwidth (approximately 2.0 MHz).

Even though the chrominance and the luminance are separated on tape, they are combined again at the output. The process produces a set of noise and interference patterns together with a reduction in the sharpness of the picture. Additionally, the color information contained in the picture is not locked to the luminance.

BROADCAST COMPOSITE RECORDERS

When broadcasters record composite video they traditionally use full-bandwidth recording formats (minimum 4.5MHz) such as 1" VTRs, that allow both subcarrier and sync to remain related. This technique allows the VTR's internal processing equipment to more easily recover the chrominance and luminance information to produce a high-resolution, locked-subcarrier video output.

Even though these recorders are very high quality, interference patterns may be generated in the video. Interference patterns (seen as noise or moiré in the picture) occur because the luminance bandwidth, which extends to 4 MHz, and the chrominance, which is modulated at 3.58MHz. This overlap in frequency causes intermodulation products to be produced due to non-linearities in the recording and playback process. [Once the chrominance has modulated the luminance, it is very difficult (expensive) to separate the chrominance and luminance without leaving additional artifacts.]

S-VIDEO COMPONENT RECORDERS (SVHS - Hi8)

S-Video (SVHS and Hi8) VCRs are medium-bandwidth component recorders. In these recorders, the luminance and chrominance (Y/C) components form a two-wire signal the components of which are processed separately. The resultant video exhibits fewer interference patterns (mainly chroma noise) than are seen in domestic composite recorders. Additional improvement is also seen on the composite outputs of these recorders due to the improved bandwidth and decoding process. (Luminance bandwidth is around 3MHz)

Newer picture monitors, TV sets, editing and switching equipment provide S-Video inputs and outputs that allow the luminance and chrominance to remain separated throughout the signal path. This process helps eliminate the encoder/decoder artifacts accumulated when recording, playing-back and displaying video.

BROADCAST COMPONENT RECORDERS

Several 3-wire component formats are used in broadcast. These formats allow the matrixed components (Y,B-Y,R-Y) from studio cameras to be recorded directly reducing still further the intermodulation by-products seen in other forms of recording.

DIGITAL VIDEO RECORDING

Among the latest developments in video recording are digital recorders which not only have superior video quality, but allow virtually unlimited dubbing generations without video or audio degradation.

TBCs/Synchronizers

Video tape recorders have to a greater or lesser degree, problems with tape jitter. This is due to a number of things including bearing noise, but is chiefly caused by the flexing and stretching of the tape as it is wrapped around inside the video recorder. This mechanical instability causes the critical timing relationships between the elements of the recorded signal, particularly the horizontal time-base, to be disrupted. Additionally, the playback heads will be slightly displaced mechanically resulting in their inability to exactly retrace the recorded path along the tape. (On tape machines whose scanners employ two heads at 180 degrees for playback, this is called dihedral error.)

One way to correct these problems, is to employ a TBC (Time-Base Corrector). The TBC processes the luminance and chrominance separately, corrects the timing errors relative to each other, and locks the subcarrier and luminance together. The output is then timed relative to a reference signal to provide a stable, locked signal.

A field or frame synchronizer has a full field or frame of memory, allowing the input signal to have correct timing relative to the output. A frame synchronizer is usually placed at the input of a switcher when the input signal cannot easily be made synchronous to the other inputs (i.e., signals received via satellite).

Switchers

Once the signal has been stabilized and timed (through a TBC, for example), it can be combined with other signals in a switcher. For a switcher to do fades, mixes, insert graphics and titles, and other effects properly, the signals at the switcher's inputs must be matched exactly in both horizontal sync time and subcarrier phase. (Subcarrier phase matching is done most accurately with a Vectorscope, whereas timing is best done with a Waveform Monitor.)

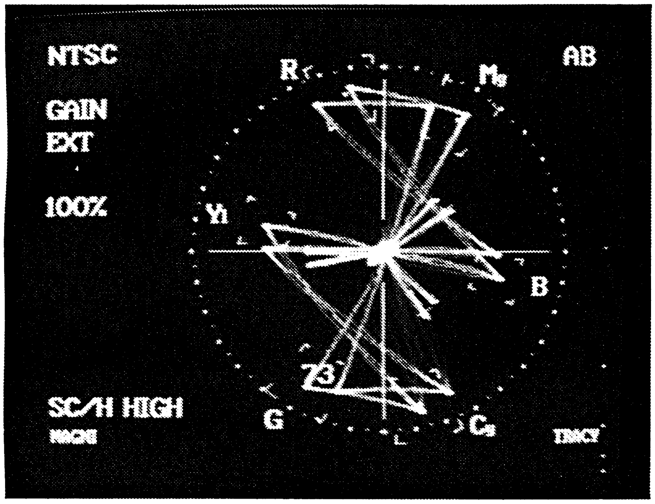


Figure 24 - Two Signals with Phase Offset (Shown on Vectorscope)

KEYING/COLOR KEY

Switchers can also perform luminance and color (chroma) keys. Keying uses a video signal to electronically "cut a hole" in the video picture, allowing the insertion of other video information into the hole. The hole may be any shape or size or may be multiple holes. The hole may be caused by the light elements of the key video signal (Luminance Key), dark elements (Inverse Luminance Key), or the presence of a certain color (Color Key), or the absence of a certain color (Inverse Color Key).

An example: Even though your local TV weatherman gives the weather report using charts, satellite pictures and animated graphics while appearing to stand in front of them, he isn't. He is actually standing in front of a solid blue (or other color) background. This blue background creates a blue signal (the Color Key) everywhere the weatherman isn't in the picture. That signal is detected by the switcher and the blue portion is replaced by video from the other video sources the weatherman wants. The weatherman can only see the combined image on monitors placed just off camera that show him the same picture you see. (It is uncommonly tricky for the weatherman to make this arrangement look natural to the camera.)

Editing

Once you have the raw material for your production on videotape you will probably want to edit the tape. Editing allows you to keep only the parts you want and to organize them in a logical sequence. Editing also allows you to combine several videotapes, studio segments, film, slides or overlays of character generators, etc, and audio onto one tape. Some inexpensive video recorders allow a certain amount of editing to be done directly; however, production edit-controllers allow the process to be done more easily and accurately. (An edit-controller permits editing different signals together once the video recorders and the switcher are properly timed and matched.)

TIMECODE

Timing signals can be added to the videotape to make editing easier. These signals are called "timecode" and fall into two different categories: The first is the VITC (Vertical Interval Timecode), which is added to the video in the vertical interval and can be recorded by many video recorders.

The second is the LTC (Longitudinal Timecode) which is recorded on an unused audio channel -- presuming of course that you have one (most consumer VCRs don't). Both of these systems permit the timecode to be added during or after the initial recording.

EDITING

Assemble editing means that segments from the master tape are put end-to-end (head-to-tail) onto a new tape.

Insert editing means that a segment from the master tape is inserted into an existing tape in a specific place, recording over what was originally there. The timing of editing points is critical and is most accurately determined with the afore mentioned Timecode. (Several new domestic VCRs allow computer controlled editing.) Professional editing is nearly always done using the insert editing technique with VBS recorded on the complete tape - usually with timecode.

Computer Video

Personal computers allow sophisticated titles, graphics and graphics animation to be done at less expense than with dedicated video equipment. However, the graphics from a computer cannot be recorded directly on a VTR (VCR) because the computer's video is an RGB (three-wire) signal that is progressively, not interlace scanned.

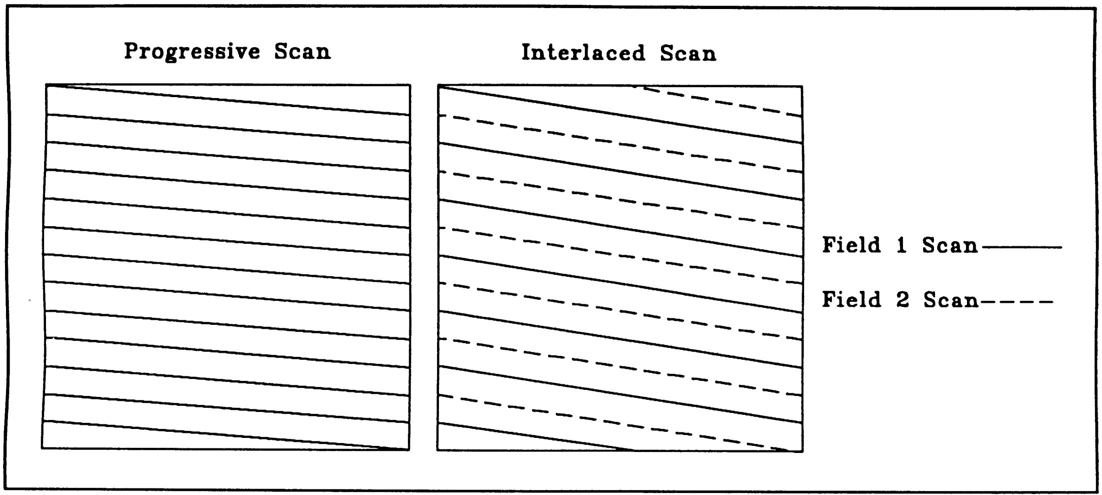


Figure 25 - Progressive vs. Interlaced Scan

The line rate (frequency) of computer RGB is approximately twice that of NTSC, approximately 30 kHz vs 15 kHz. Additionally, the different graphics formats (EGA, CGA, VGA, etc.) have different numbers of lines per field. eg: 200 X 320, 640 X 480, 800 X 600, 1024 X 768, and 1280 X 1024. All these formats must be scan converted and properly encoded to get a recordable NTSC signal.

ENCODING LEGAL COLORS

Encoding computer graphics is a critical process in that computer RGB video allows some colors to be generated that would be illegal colors in NTSC (i.e., not broadcastable). That is, these signals fall outside the amplitude limits established for the NTSC system. For example, if R, G and B are fully on, you get 100% white. Since in this case no modulation products are generated in the encoder, the result is "legal". If you turn off one or two of the RGB colors leaving the others at 100% saturation, the encoder will try to generate modulation products of a greater than 75% saturated color, thus producing an "illegal" color. (As you remember, the NTSC signal requirements allow 75% saturated color. Therefore, certain values of chrominance between 75% and 100% are not allowed in the composite signal and must be limited.) Some encoders simply clip the color signal so that illegal colors cannot be generated. This results in incorrectly saturated colors even though the signal is within the 75% limits.

BANDWIDTH

Additionally, the bandwidth of the computer's graphics needs to be reduced in the encoding process to meet NTSC standards and be recordable. The process of encoding must do this filtering correctly to keep as much picture detail as possible, and yet reduce unwanted artifacts such as "ringing" (black and white lines appearing next to sharp edges on the graphics) and dot crawl (colored dots moving along sharp chrominance edges).

COLOR SUBCARRIER BALANCE

Subcarrier modulation in the encoder must be linear and not vary over the entire luminance amplitude range to avoid different levels of the video shifting to incorrect colors or saturation.

ENCODER GENLOCK

Some encoders genlock to the video from a VCR, and overlay graphics by fading and keying. The genlock process is very critical in graphics encoders because the encoder must have the ability to provide a stable lock to low-cost VCRs. The genlock must demonstrate immunity from video noise and line voltage interference (hum) in order to prevent picture breakup and excessive jitter.

KEYING BANDWIDTH

The keying bandwidth is also important to avoid artifacts appearing around the key. If the keying is too sharp, you will see colored dots around the edges.

RF vs Baseband

The signal we've been talking about is called video -- more correctly, baseband video. Baseband video has a bandwidth up to approximately 4 MHz. The baseband audio signal is carried on separate cables. If the signal is to be broadcast, the video is modulated with the visual carrier signal of a particular frequency (channel) and becomes an RF (Radio Frequency) signal. The audio is modulated on a separate audio carrier at a frequency 4.5MHz above the visual carrier. This is just above the 4MHz upper sideband limit of the visual carrier so the two don't interfere with each other. This combined signal is then transmitted over the air or through a cable system into the home.

Professional de-modulators, used for precise monitoring of transmitters, sometimes insert a pulse in the vertical blanking that is the equivalent of zero carrier. This permits monitoring peak white at 100 IRE and zero carrier at 120 IRE, with sync being maximum modulation.

BROADCAST STANDARDS

The video standards SMPTE RP170, RS170A, and proposed standard SMPTE 170M defines the parameters for making a correct NTSC signal. These strict video quality requirements are such that only very carefully designed graphics encoders may be used successfully on the air.

PAL Video

The discussion so far has been about the NTSC system. The PAL system is similar but has several major differences.

FREQUENCIES

Most PAL systems have 625 scan lines and a field rate of 50Hz, whereas NTSC has 525 scan lines and a field rate of 60Hz. The vertical sync pulses (serrations) are made up of 5 half-line wide pulses instead of the 6 found in the NTSC system.

VIDEO LEVELS

The luminance amplitude for black is 0 volts with no setup so that the blanking level is the same as black. Peak white is 700 mV and sync is -300 mV to make a total signal amplitude of 1 volt -- the same as NTSC.

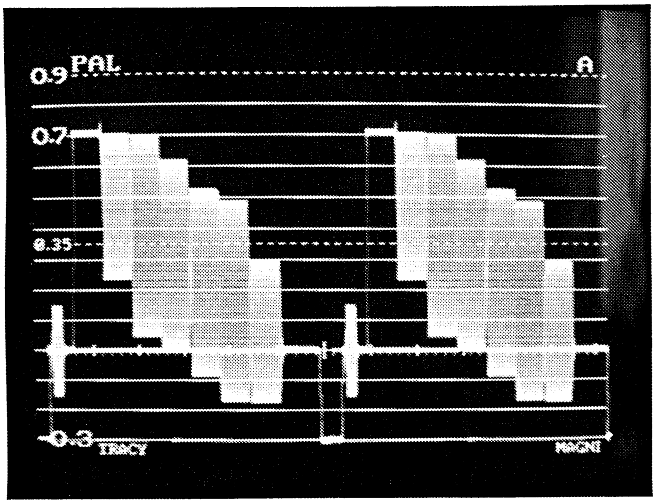


Figure 26 - 75% PAL Color Bars (Waveform Monitor)

COLOR

The color subcarrier frequency is 4.43MHz (exactly, 4.43361875MHz.) rather than the 3.58MHz subcarrier used in NTSC. To reduce dot-crawl on colored edges and allow black and white to be displayed without interference, the subcarrier is a direct ratio of the line rate with an offset of 25 Hz.

There are 283.75 cycles of subcarrier per line so that the peaks of the subcarrier are offset by 1/4 cycle (plus the 1/360 cycle component of the 25Hz offset) each line. This offset means that 8 fields must go by before the same color phase repeats. This results in an eight-field color frame sequence.

SUBCARRIER MODULATION AND FRAME DETECTION

The color is modulated in the R-Y(V) and B-Y(U) axis with equal bandwidth. The phase of the V axis is inverted each line -- hence the name Phase Alternating Line or PAL. The burst is generated on each line by the vector sum of the U axis (180°) subcarrier and the switching (90° and 180°) V axis subcarrier resulting in bursts at 135° and 225° on alternating lines.

This alternation allows the detection of PAL phase and the difference between fields 1 and 3. The SC/H phasing allows the detection of the sequence between fields 1 and 5. Therefore, the full 8 field sequence can be detected.

VIDEO PROCESSING

The video processing, recording and editing of this signal is similar to that of NTSC except that the equipment used must be designed for the PAL system.

Application Note 3 - The Waveform Monitor

MONITORING VIDEO

In the early days of television, oscilloscopes were used to monitor the video signal. The oscilloscope is a complex instrument with a number of different controls which are not needed to monitor video ... and which make it difficult to operate. Because a video signal is one volt in amplitude and has certain fixed timing relationships, creating a simplified, dedicated oscilloscope for television video monitoring became a practical solution. The instrument is called a waveform monitor.

The television signal has a number of parameters that need to be monitored to produce a program, record, and then transmit that program to the viewer while maintaining high (and legal) signal quality. The video signal is explained briefly in the paragraph below and more fully in Application Note 2 - NTSC Video.

THE WAVEFORM MONITOR'S VIEW OF NTSC VIDEO

The display of a waveform monitor includes a calibrated scale called a graticule. A baseline, located on the graticule approximately 1/3 of the way up from the bottom, is the point from which most measurements are made.

Video is shown graphically above the baseline with brighter elements in the picture shown nearer the top of the display, and darker elements shown nearer the baseline. In other words, the greater the brightness of an element in the video, the further above the baseline it will appear. (White produces the brightest image and therefore it will appear at the top of the display. White is followed in descending order by all gradations of light gray through black.)

Along one side of the graticule is a scale which is marked in units of IRE*. This scale places 0 IRE at the baseline (which is the blanking level), 7.5 IRE at setup (which is the black level), and 100 IRE at peak white. Sync pulses are negative and go from 0 IRE (the baseline) to -40 IRE which is near the bottom of the display.
While the IRE scale is a handy way to keep track of the picture amplitudes in percent (%) and other relationships between the parts of a signal, in reality, NTSC video is measured in 1000ths of a Volt called milli-Volts, abbreviated mV. In NTSC, the -40 IRE sync level represents a voltage of -286mV, and the 100 IRE peak white level represents a voltage of +714mV.

* The IRE scale allows easy calibration of the waveform and was named after the Institute of Radio Engineers. (The group later renamed itself IEEE, The Institute of Electrical and Electronic Engineers, so it could have been worse.)

The peak-to-peak amplitude of the signal is found by the addition of the sync level to the white level, or: -286mV and +714mV equals 1000mV or 1.0 Volt. (The IRE scale totals -40 IRE plus +100 IRE which equals 140 IRE peak-to-peak.) (PAL video also totals 1.0 Volts, but differs in that the picture information is 700mV and sync is -300mV.)

A position knob allows moving the video display up or down to match the graticule. A vertical magnifier is provided to increase the amplitude resolution. Position the point on the signal to be magnified on the baseline and activate the magnifier. This will allow monitoring or measuring the area of concern.

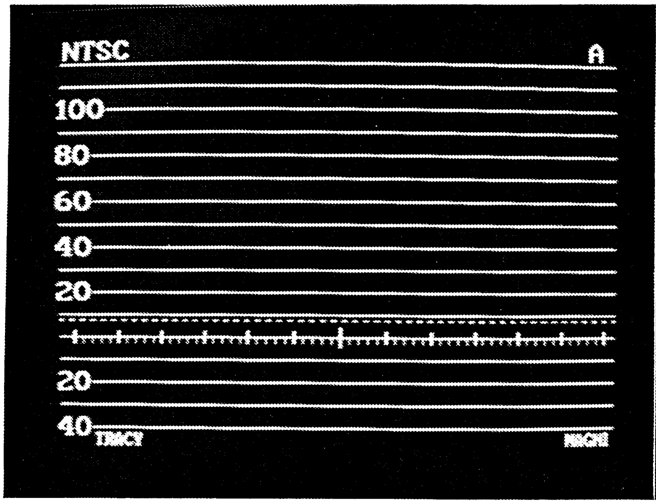


Figure 27 - NTSC Graticule showing IRE Levels.

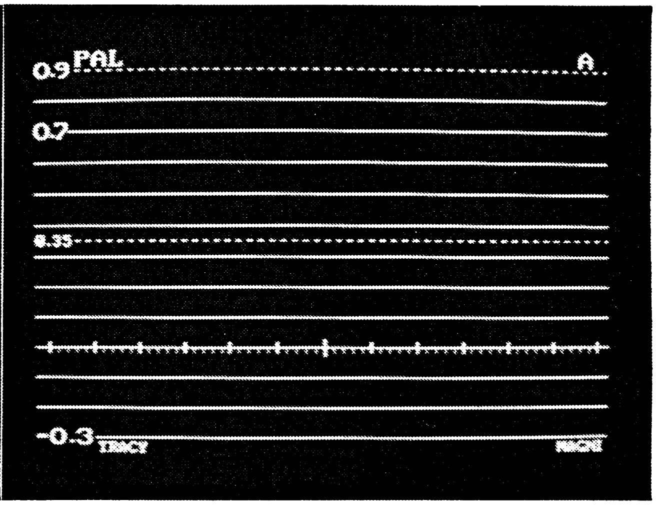


Figure 28 - PAL Graticule showing Volts Scale.

SWEEP SPEEDS

The timing of the video signal is displayed along the horizontal axis of the waveform display. The timing resolution on the graticule is set by the selection of one of the three typically available sweep speeds. The three sweep speeds allow the full width of the screen to display the following:

1. One-line (1 horizontal line)
2. Two-lines (2 horizontal lines) or,
3. Two-fields (1 Frame or 525 horizontal lines)

The one-line display shows one horizontal line of the picture scanned from left to right. The two-line display shows two lines. The two-field display shows the equivalent of two scans of the video picture from top to bottom. (Two scans = two fields, or one frame, or 525 horizontal lines) viewed across the waveform display.

In the case of the one-line display, the horizontal sync pulse begins the sweep on the left. First displayed is part of the positive-going sync pulse, then color burst, and then the end of blanking. At the end of blanking, the video portion of the signal begins. The sweep then travels across the display to the right, displaying all the video in that line. (The video on the left side of the waveform monitor is also the video on the left side of the TV picture.)

If the waveform monitor is in the two line mode, part of a sync pulse with burst will be displayed at the left edge followed by a line of video, a complete sync pulse with burst at the center, the next line of video, and another partial sync pulse at the end of the sweep.

The one and two line modes allow monitoring of the peak brightness across an entire field, since all scan lines in the field are overlaid on top of one another on the waveform display as the picture is scanned.

In the two-field mode, each line is displayed individually so that the brightness down the field (top to bottom of the picture) can be monitored from left to right on the waveform display. The trigger selection feature allows the waveform monitor to be set to display the start of the sweep at Odd Fields or Even Fields. The retrace process causes a portion of one Field's vertical interval to be missing. To monitor a complete vertical interval, magnify the center of the display -- which, if you are set to trigger on Odd Fields, will show you the vertical interval for Even Fields. (If set to trigger on Even Fields, the vertical interval for Odd Fields will be displayed.) In the one or two-line modes, the magnifier provides the resolution necessary to permit the viewing of pulses or edges (steep transitions) to examine risetimes or ringing.

The horizontal (or timing) magnifier allows increased resolution for timing measurements and allows you to view individual lines throughout the frame.

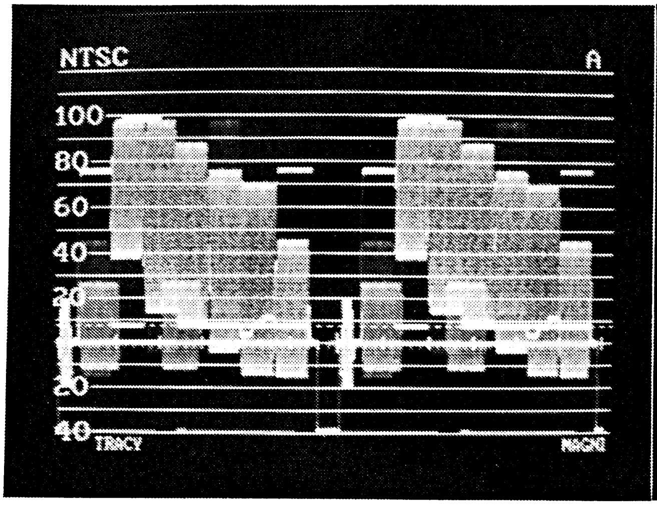


Figure 29 *- 2-Horizontal Line Display (Waveform Monitor)*

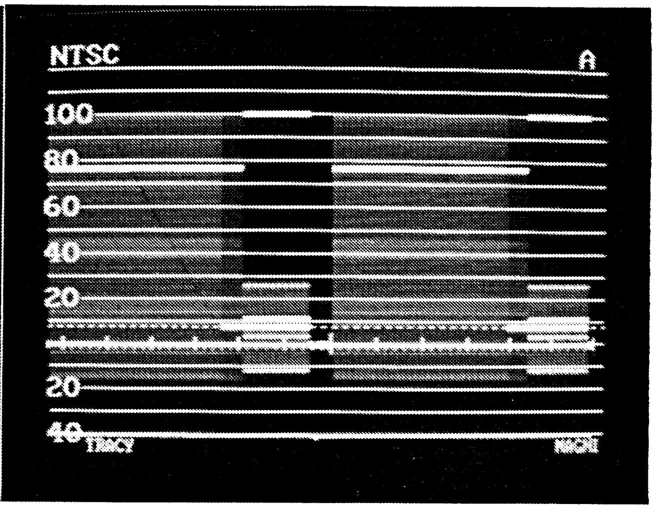


Figure 30 *- 2-Field Display (Waveform Monitor)*

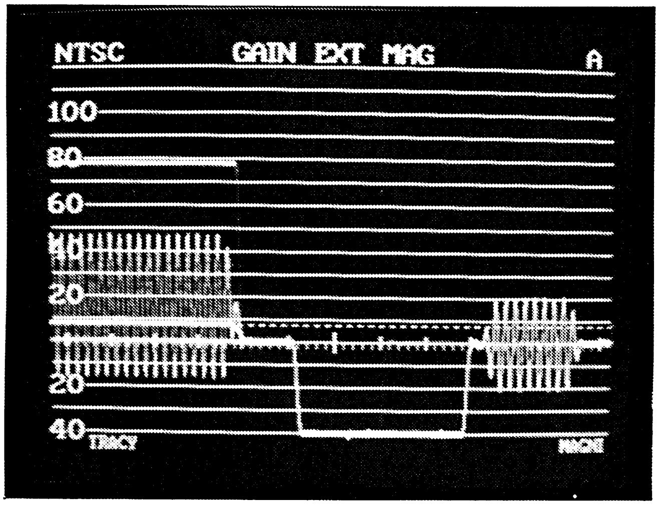


Figure 31 *- A Horizontally Magnified Waveform of Horizontal Sync and Burst*

INPUTS

Video

Each input normally consists of two connectors in a loop-thru configuration. This allows the signal to be input to one connector and output from the other connector to the next unit. The final connector in the series must be terminated in 75 Ohms to give proper signal amplitude without electrical reflections.

Three-input waveform monitors allow monitoring 3 composite signals or 1 component three-wire signal such as GBR, or Y,B-Y,R-Y. Six-input waveform monitors allow monitoring of two complete component sets and permit amplitude and timing comparisons between the two signals.

These inputs may be viewed in several ways. One way is to switch to each input one at a time. In newer waveform monitors there are several different modes that allow viewing multiple inputs. One of these modes allows three signals -- channel A, channel B and channel C -- to be paraded across the display. This mode allows viewing three composite signals at once or one three-wire component signal.

The second three-input display method is the alternating mode. In the alternating mode, each of the signals is overlaid with the second and third inputs being overlaid over the first. The alternating display mode allows an easy comparison of amplitudes and timing, whereas the parade input allows viewing of each of the signals together on the display to observe amplitude differences.

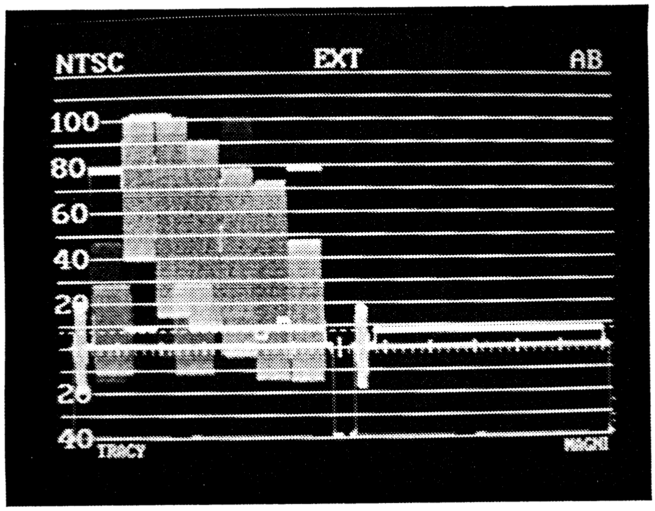


Figure 32 - Parade of Two Inputs (Waveform Monitor)

External Reference

An external reference input allows connection of a timing reference signal. Many studios provide this signal called VBS (Video, Blanking and Sync) to lock equipment so that their outputs can be timed to be coincident at the switcher. With the waveform monitor in external reference mode, the timing of each input can be compared to the other inputs.

FILTERS

Several different input filter modes are available:

1. Flat response - no filtering
2. The low-pass filter removes the high frequency information particularly the color information for testing just the luminance or brightness levels.
3. The bandpass filter allows just the chrominance or the color information to be displayed.
4. The differentiation filter tests luminance linearity. Luminance linearity is verified by putting an unmodulated staircase through the system under test and then viewing the staircase differentiated on the waveform monitor. The result will be a series of pulses. These pulses (ignoring those created by sync edges), if luminance linearity is correct, will all be the same amplitude.

Filtered signals may also be paraded. For example, the left line of a 2-line display might be flat (unfiltered) and the second line of that display might be low-pass filtered. This will allow simultaneous viewing of a signal with chrominance and without. Another example might be to view the flat signal on the first line and, using the bandpass (chrominance pass) filter, view just the chrominance on the second line. You might also parade 3 signals, i.e., the first might have a flat signal, the second, a low pass filtered signal, and the third, a bandpass filtered signal.

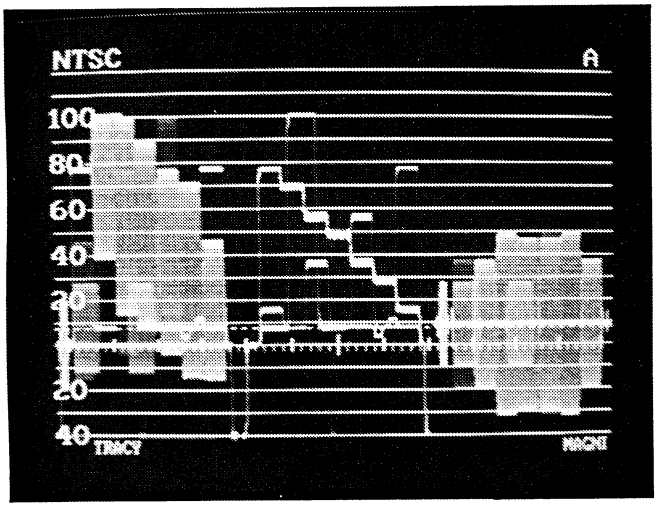


Figure 33 - One Input with Paraded Filters

INPUT CLAMPS

The DC level of the input may vary and cause the position of the baseline to move on the screen. Input level clamps are provided to hold the baseline's position steady. The waveform monitor is normally left in the slow-clamp mode so that any 60Hz (50Hz in PAL) ripple induced on the video from AC power sources will be immediately visible. The slow clamp allows you to measure the amount of ripple present on the signal.

The fast-clamp, on the other hand, is used to significantly lower the effects of ripple from AC power sources, to allow other signal measurements to be made.

TIMING

Waveform monitors can display the timing of the signal to allow checking for accurate horizontal and vertical sync signals, but, more importantly, they can also display the timing between two signals.

An external reference input provides a fixed reference to check the timing of one signal relative to the timing of second or a third signal and so on throughout your system. If the sync pulses of both signals are not in the same position on the display, there will be an offset in time between the two. If not corrected and these signals are input to a switcher, there will be a horizontal shift in the picture during transitions between signals.

In the field mode, the field timing and field number can be checked to make sure that all field numbers match for the signals.

Blanking width is another parameter of the signal that a waveform monitor can verify. Verification must be done so that the blanking width is not too narrow, which would interfere with sync, or too wide, which would give you black stripes around the picture.

In the 1 or 2-line mode, the burst signal for color is displayed just after sync. The timing and position of this burst can be checked. The Vectorscope is a much more accurate instrument for checking or setting the phasing between signals. See: Application Note 4 - The Vectorscope.

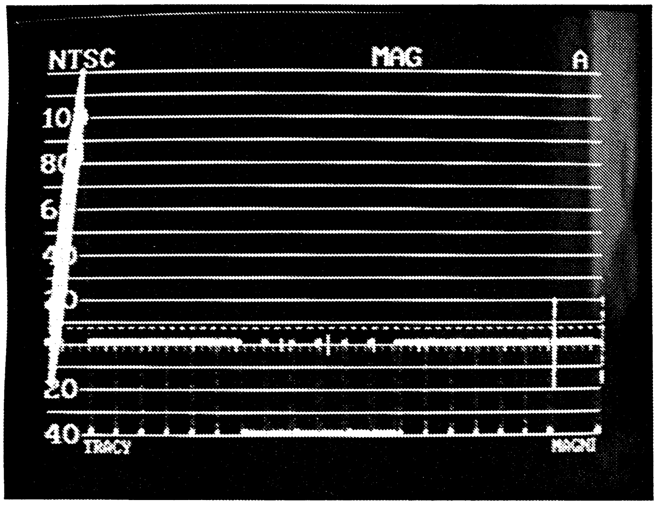


Figure 34 *- Waveform Display of Field 1 Vertical Sync.*

SYSTEM TESTING

TRANSIENT RESPONSE

Transient response testing of the video signal is important because the signal may pass through many pieces of processing and transmission equipment. Certain test signals that have pulses, modulated pulses, and bars are used to test the transient response of a system. A half-line white bar tests for tilt which, if present, will cause one edge of the bar to be brighter than the other.

Another example: the pulse and bar test allows you to verify that the system under test carries high frequencies (needed to form the pulse) equally with the low frequencies (needed to form the bar) by comparing the amplitudes of the two. The pulse and bar test also allows you to see that no ringing (which would show up on the picture monitor) precedes or follows the pulse.

CHROMINANCE

The modulated pulse test signal is a luminance and chrominance signal put together, such that ideally the baseline would be flat. If a gain difference exists between the chrominance and luminance, the baseline will bow up if the chrominance is too low, or bow down if the chrominance is too high relative to the luminance.

If the baseline of the modulated pulse test signal forms an "S" shaped curve, then chrominance-to-luminance delay or advance is present. If the baseline bows up at the start of the pulse, then bows down, this means the chrominance is delayed relative to the luminance. If the baseline bows down at the beginning of the pulse, then bows up, the chrominance is advanced relative to the luminance.

FREQUENCY RESPONSE

Frequency response flatness can be monitored with a multiburst signal. This signal normally has six frequency packets ranging in frequency from 500kHz to 4.1MHz. If the system under test alters the amplitude of these packets, then the frequency response of the system may be in error.

These are just some of the test signal parameters that could be monitored on a waveform monitor.

VERTICAL INTERVAL SIGNALS

VERTICAL INTERVAL TEST SIGNALS (VITS)

In most transmission environments, Vertical Interval Test Signals are added to the vertical interval on lines 17 through 19. Test instruments with line select, such as the Magni 500 Series can view just those lines. (See Magnifier below for MM-400 operation) For example, a transmitted signal could have Color Bars, Multi-burst, Staircase, Modulated Pulse and Bar, and 2T Pulse during the vertical blanking. Selecting lines 17 through 19 in the vertical interval allows viewing just those lines on the waveform monitor without picture information interfering with measurements.

OTHER VERTICAL INTERVAL SIGNALS

Other signals may be included in the vertical interval for control and setup. These include:

- VIR (Vertical Interval Reference) provides luminance gain, setup, chroma-gain and chroma-phase reference.
- VITC (Vertical Interval Time Code) provides a frame-by-frame time code for post-production edit timing.
- Source Identification and Control Signals
- Closed Captions for the Hearing Impaired
- Copyguard, an electronic anti-theft scheme to protect videotapes from being duplicated by unauthorized personnel.
- Other items planned for the future include signals to permit the operation of ghost-canceling circuitry.

CAMERA SETUP

The line select can be set to 16 lines and monitor the camera response to a setup test chart to verify the response through the video field.

MM-400 VERTICAL MAGNIFIER

The MM-400 does not have line select but does provide a higher Vertical Magnifier (50X) to allow viewing the signals in the vertical interval and to setup cameras. Lines are selected by moving the position control to scroll the display through the field.

MEMORIES/RESET

MM-400 provides a *RESET* through the menus to allow the operator to return the instrument to the factory settings.

The 500 Series instruments provide memories to simplify operation. These memories can contain instrument setups such that the push of a button will recall the settings for a certain measurement or a special operational mode.

OPERATIONAL

In most studio operations, waveform monitors are used to verify many things. Among them are:

1. Monitoring the presence of a correct video signal.
2. Matching the color and brightness of scenes for studio cameras.
3. Monitor the signals going to the switcher so that sync is aligned to reduce picture shifts when switching.
4. Monitor the output from a VTR to check for excessive sync jitter on the signal.
5. Matching video sources.
6. Examination of detail problems.
7. Balancing transitions of sources between racks.

SUMMARY

Waveform monitors are an essential tool for setting up television systems correctly. Their correct use improves the quality of video productions.

Application Note 4 - The Vectorscope

Color

Color television displays and cameras generally use three color signals: Green, Blue and Red (GBR) to make all the other colors. These signals are derived essentially by placing Green, Blue, and Red filters in front of three black and white cameras, making each camera sensitive to only that color. The difficulty with GBR is that it is three signals, each with nearly the same transmission requirements (bandwidth) as one black and white signal. Left at that, a GBR television system would have required three television transmitters on three channels to get one color TV picture -- not too practical. Something had to be done to compress the three color signals into one that could be transmitted in a similar way to the monochrome signal.

In the 1950s, practical color television systems were designed which were compatible with existing monochrome systems. These systems were created by adding the modulation of a 3.58 MHz subcarrier for NTSC (4.43 MHz subcarrier for PAL) to the previous monochrome video signals.

These subcarriers are phase modulated to define the hue of the color, and are amplitude modulated to define the saturation of the color. Thus the three signals (GBR) were combined (encoded) into one signal called composite video.

Waveform Monitors vs Vectorscopes

Waveform Monitors were the first practical way to make television signal timing and amplitude measurements. With them you can view sync, burst, blanking, and the amplitudes of the luminance (or brightness) portion of the signal. They are, however, not as practical for viewing the information contained in the color portion of a composite video signal. (The amplitude of the subcarrier and the chrominance components can be seen on a Waveform monitor, but the phase relationships between the components can not.)

Vectorscopes, on the other hand, can display amplitude and phase relationships of the chrominance components, but are of little practical value in displaying the other parts of the signal. Vectorscopes allow viewing: the modulation phase (hue), the subcarrier amplitude, the subcarrier's phase relationship to subcarriers of other signals, and the color amplitude (saturation) of a specific color -- all with great accuracy.

The display on a vector scope is polar (like a compass) with zero chrominance amplitude at the center of the display. The 0 degree axis is horizontal to the right of center (East).

The 180 degree axis (with the reference burst) is horizontal to the left of center (West). This horizontal axis from 0 degrees, through the center, to 180 degrees is called the B-Y axis (U axis in PAL). The vertical axis from 90 degrees (North), down through the center, to 270 degrees (South) is called the R-Y axis (V axis in PAL). Any amplitude or phase in video may be displayed by deflecting the display beam in the B-Y and R-Y directions corresponding to the amplitude and phase of the subcarrier on the video signal.

When the color television system was defined, two axes of modulation were decided upon which are 90° apart. In the early days, the modulation was on the -I (-I = -57° from B-Y) and Q (Q = +33° from B-Y) axes. The initial reason for selecting these axes was to permit two different bandwidths for the modulation. This turned out to be problematic so in recent years, when the requirements were changed allowing equal bandwidth for both phases, the B-Y (0 degree) and R-Y (90 degree) axes were selected. Most vectorscopes now decode on these axes.

The Green, Blue, and Red (GBR)* signals from the camera are first matrixed to a luminance and two color difference channels known as Y/B-Y/R-Y. The Y signal is the luminance or monochrome representative signal and is derived from a matrix of all three GBR signals. The color difference channels: B-Y (Blue minus the luminance value) and R-Y (Red minus the luminance value) are derived from differing matrices of the GBR signals. (In older equipment, different transcoding matrices resulted in the Y, -I and Q signals discussed earlier.)

* GBR is referred to as RGB by computer people (and by broadcasters as well until component video systems were established).

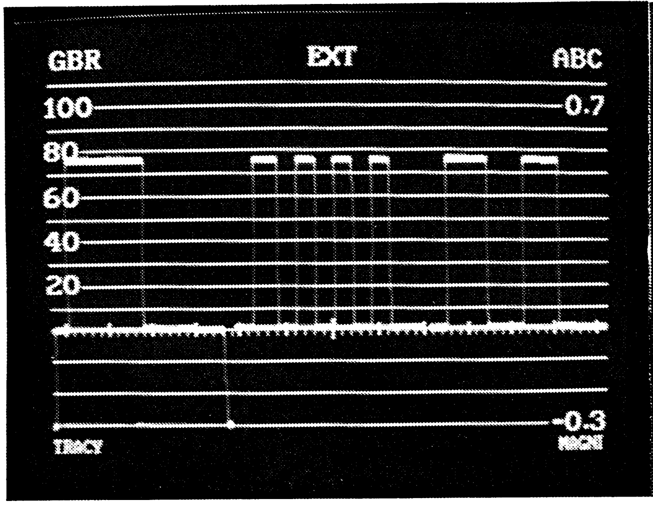


Figure 35 - GBR Signal Paraded

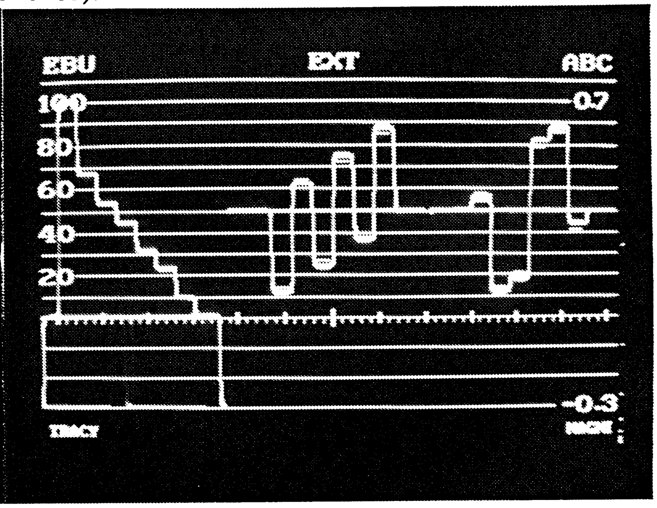


Figure 36 - Y,B-Y,R-Y Signal Paraded

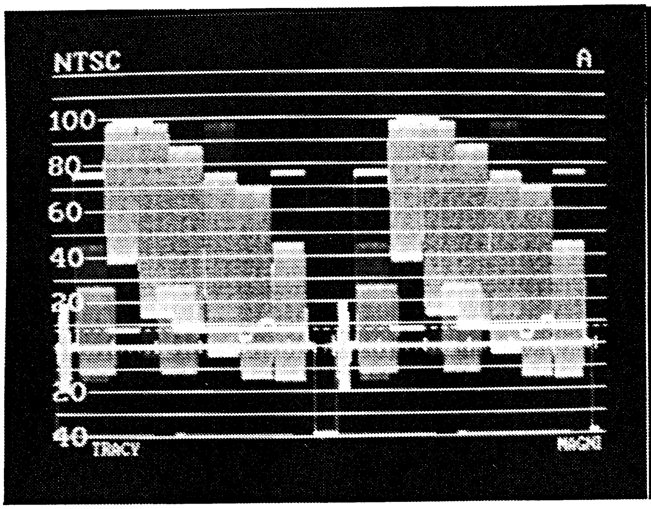


Figure 37 - Color Bar Waveform Display.

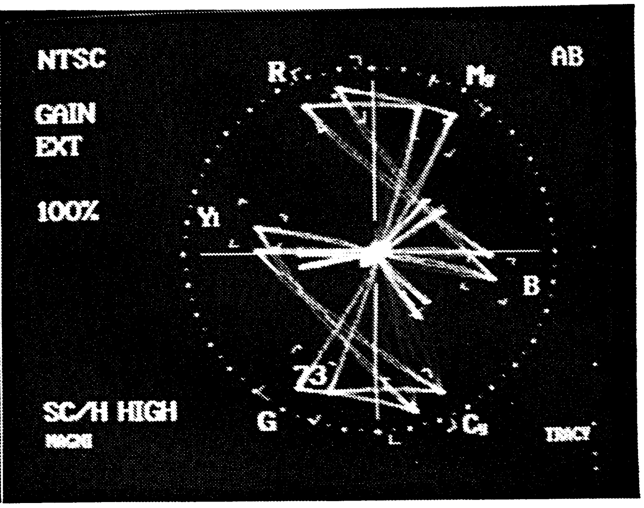


Figure 38 - Vector Display of Two Color Bar Signals Offset in Phase by about 15 Degrees.

The B-Y and R-Y signals then modulate the amplitude of a subcarrier on the 0 and 90 degree axes respectively. The resulting subcarrier is added to the luminance to make a composite color video signal (see Figure 39).

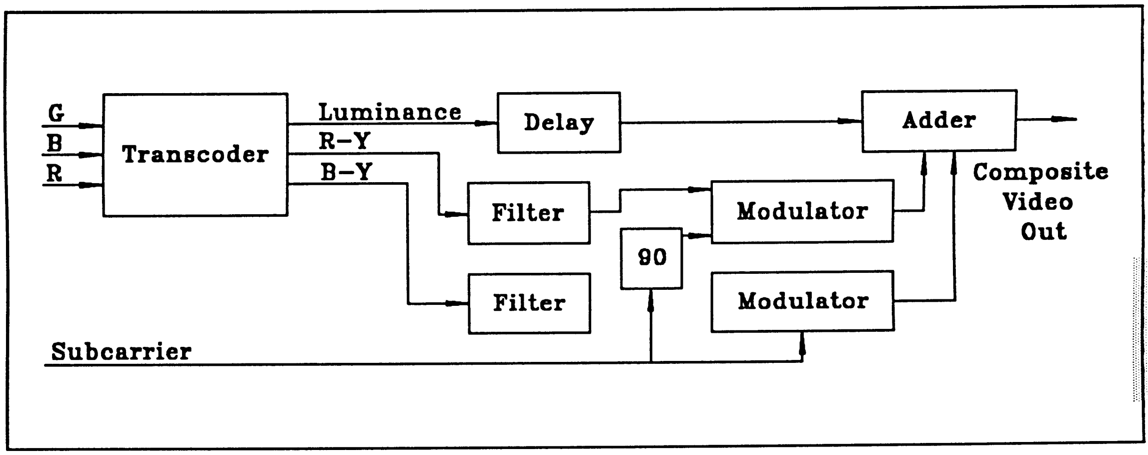


Figure 39 - Block Diagram of Color Encoder

Vector Display

The Graticule

A Vectorscope graticule consists of several parts. Note that the numbers of the descriptions below refer to the example in Figure 40.

1. A circle (the "Compass Rose") with markings around it in 2 degree increments is the main feature of the display.

2. The horizontal line through the middle of the circle is the B-Y (X) axis, with 0 degrees to the right of center, and 180 degrees to the left of center.

3. The vertical line through the middle of the circle is the R-Y (Y) axis, with 90 degrees up from center, and 270 degrees down from center.

4. Tic marks on the horizontal line to the left of center (the 180 degree line), show where burst should be when displaying 75% and 100% saturation color bars. Tic marks along the horizontal line to the right of center show the projection of Color Bars onto the B-Y axis.

5. The small "+"s (surrounded by boxes) indicate where color bars should land when displaying the color bar signal.

   (If you look slightly above the left center line, you'll see a "+" for yellow (Yl). Then, going around clockwise, there will be +s for red (R), magenta (Mg), blue (B), cyan (Cy) and green (G).

6. The boxes around the "+"s help establish limits for phase and amplitude and help set up tolerances in the system. The smaller boxes indicate ±2.5% and ±2.5 degree errors. The larger boxes indicate ±10% and ±10 degree errors.

   These boxes are used for testing with a color bar signal which will have dots that should fall in these boxes. These dots correspond to the colors in the color bar signal. A dot shifted in or out from the box center (in reference to the center dot) indicates an amplitude or saturation error. A shift around the circle to the left or right of the box center (again, in reference to the center dot), indicates a phase or hue (color) error.

7. A vertical scale on the left side, on the X axis, gives an indication of differential phase and/or differential gain errors. (See Differential Phase and Gain Errors below)

   When using the PAL system additional marks are provided.

8. PAL burst vector markings occur along the 135 degree and 225 degree axis show where burst should be for 75% or 100% saturation during the alternating lines of PAL vectors.

9. In PAL an additional set of Xs and boxes mirror the first set about the B-Y axis. This allows the display of both PAL phases. Signals falling in these boxes are in different directions (phases) relative to the subcarrier or burst vector.

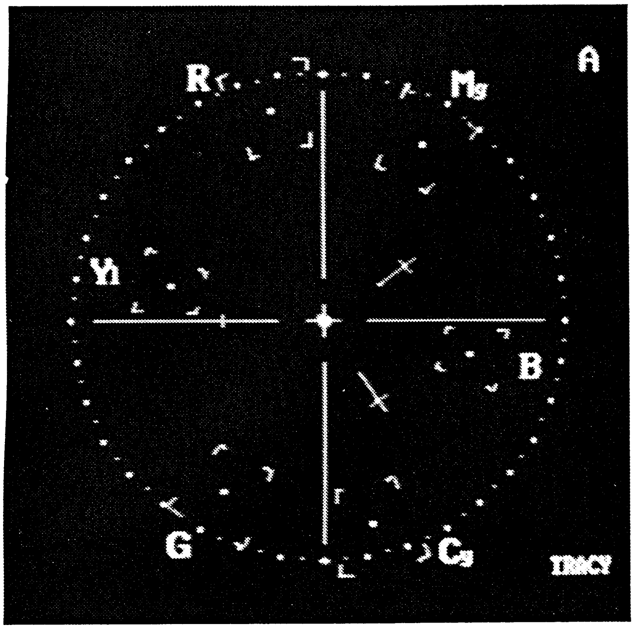


Figure 40 - *NTSC Vectorscope*

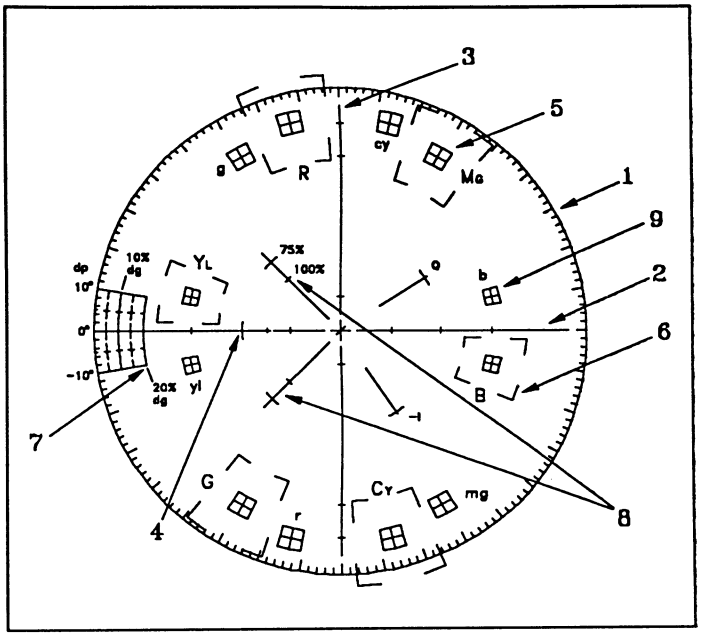


Figure 41 - *Dual-standard (NTSC and PAL) Vectorscope Graticule with Text Reference Numbers*

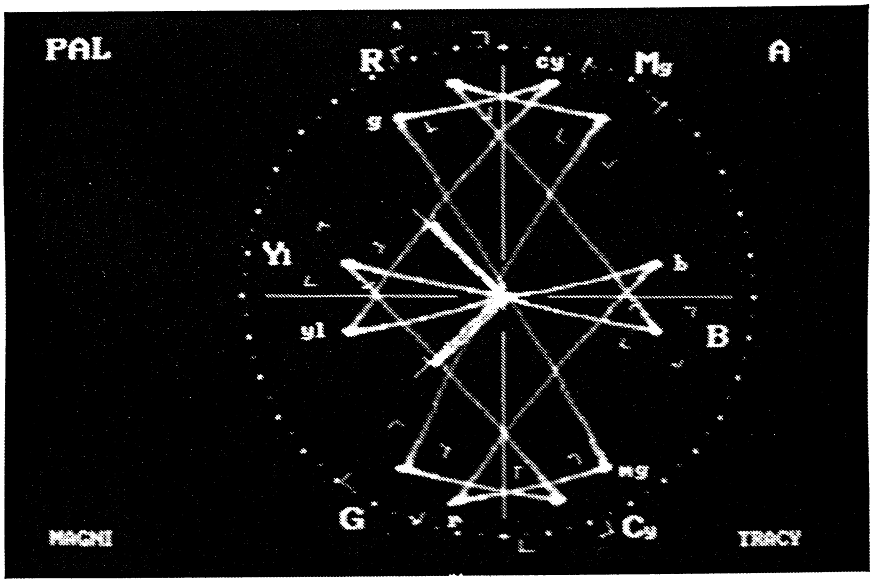


Figure 42 - *PAL Vectorscope Graticule*

BURST

A burst of subcarrier in the horizontal blanking interval provides the color phase reference. The burst will be displayed at 180 degrees on the vectorscope for the NTSC signal (alternating 135 and 225 degrees in PAL). The vectorscope (and other processing equipment) lock to burst. Burst will be locked by the vectorscope to a point along the 180 degree line on the display.

(In PAL the burst occurs at 135 degrees on one line and 225 degrees on the next. In the +V mode this averages out to 135 degrees. The PAL alternating phase can be determined by which line's burst is at 225 degrees.

Since the amplitude of the burst is tightly specified and therefore assumed correct, newer equipment may also use burst as an amplitude reference to correct subcarrier gain errors.

GRAY LEVELS

The center of the vector display is zero modulation (no color). The majority of the average television signal will be at that center point, which means there is no chrominance. Video blanking and all white through black (gray level) portions of the signal, for example, have no chrominance.

COLOR SATURATION AND HUE

The circuitry in a vectorscope is the reverse of that in a color encoder, demodulating the subcarrier into B-Y and R-Y. This provides a display of vectors equivalent to the saturation and hue of the video.

When color is present, the more the signal deflects from the center dot, the more the saturation of the color. The deflection shows the amplitude of the subcarrier on the video. This can also be viewed on a waveform monitor as the subcarrier amplitude in the chroma-pass filter mode.

The direction the signal deflects indicates the phase of that modulation indicating the hue of the color.

On a Color Bar signal, there are three different amplitudes of subcarrier with six different phases that should fall within the 6 graticule boxes for these colors.

Video Production Applications

COLOR PHASING

Phase matching of signals needs to be done if the signals are going to be routed to a switcher. If you are going to fade or key between two signals and, for example, the burst phase is not matched, the hue of the picture may shift between the two signals as they are faded.

If the phase of reinserted burst relative to the picture information is incorrect, the coloration of the picture will be wrong.

EDITING/COLOR CORRECTION

Video matching with a color corrector can be done before an edit between two scenes to make the transition look more natural. Additionally, the edit time can be chosen by looking at both the pictures, the waveforms and the vectors. A picture monitor allows matching the hue and saturation of color in the pictures.

CAMERA SETUP

In setting up cameras, a vector display can help correct color balance errors. This is usually done by directing the camera toward a standard monochrome step-chart and displaying the encoded video on the vectorscope. Adjustments are then made to the camera to produce the smallest vector dot.

Additionally, the vector display can be used to set the subcarrier phase of two or more genlocked cameras so that they can be used with a switcher or edited to videotape in a production.

DISPLAY REFERENCE

The vectorscope has both an internal and an external reference. When comparing the phase of different signals ("phasing"), the use of external reference is advised so that the bursts of all signals can be set to match the reference. That way, when they reach the switcher, they will be matched in color correctly and not cause color shifts.

When internal reference is used, set one of the signal's bursts to the 180 degrees phase mark, and then show the difference between that signal and the other signals by viewing the signals simultaneously.

SC/H PHASE AND COLOR FRAME

Some vectorscopes have SC/H (SubCarrier/Horizontal sync) phase indicators. The SC/H phase of a signal is the phase relationship between the subcarrier and the luminance signals. When the SC/H is correctly set, the color frame can be detected and can be matched between two signals.

System Test Applications

DIFFERENTIAL PHASE AND GAIN ERRORS

Differential phase and gain errors are caused by the interaction of the luminance level on the subcarrier. Differential phase error is defined as the change of subcarrier phase at different luminance levels caused by non-linearity. Similarly, differential gain errors are those created by a change of subcarrier amplitude at different luminance levels. These errors should be adjusted to be minimal amplitude using a staircase or ramp signal.

With the modulated ramp vector set to 180 degrees, a spreading of the vector dot in the vertical direction is a differential phase error. A spreading of the dot along the horizontal axis is a differential gain error. These errors are caused by the subcarrier response in some incorrectly set equipment to be different at black than it is at white. (This error may show in a vector display of color bars when the dots do not fall within the boxes, however the ramp signal gives a better indication.)

ENCODING ERRORS

If errors are found in processing equipment, it should be noted on which axis the error occurs. For example, if both blue (B) and yellow (Yl) are low in amplitude, it may be that the B-Y axis gain is not correct. If red (R) and green (G) are low, it may mean that the R-Y axis gain is not correct. If red (R) and green (G) are incorrect in phase, the quadrature adjustments that establish the 90° relationship between the B-Y and R-Y axes may be incorrect.

If the modulation process is in error, white through black areas may exhibit a chrominance offset. This will shift the position of the center dot. This chrominance offset results in grays being tinted -- the colors within the scene will also be incorrect.

CONCLUSION

Proper use of the vectorscope can improve the color quality of your video output and reduce the time needed to make your video productions.

Application Note 5 - Test Signal Generator

When playing back your videotapes, do the colors change in saturation or hue? Does the color information bleed from one part of the picture into another? Do white lines develop next to white or black transitions on multi-generation tapes? If you are seeing any of these things, improper signal processing in your system may be creating signal distortions. These distortions can easily be detected using a Test Signal Generator with a Waveform Monitor and a Vectorscope.

If you want professional looking videotapes you must do what video professionals do. You must use the specific signals generated by Test Signal Generators, send the signals through your system, then observe them on a waveform monitor and vectorscope to see how your system might have affected (distorted) them. It's as simple as that. This approach helps you to detect problems anywhere in your system. Once you know where your problem is, you're well on your way to eliminating it.

Routine testing of your system in this manner (once obvious problems have been eliminated) will also help you maintain system quality making productions easier and faster while reducing costly re-shoots.

Types of Distortion

The most common distortion found in video is signal amplitude error (or more commonly, gain error). For example: the signal level out of a VCR may be 20% high at 1.2 volts or 20% low at 0.8 volts instead of the nominal 1 volt. This may not show up as a problem at first, but after it's gone through several generations while editing, the scene will no longer look as it originally did. (At 20% low, third generation tapes will have less than half of the original video level. When this gain error is compensated for by the amplifiers in processing equipment, the background noise is amplified along with the video resulting in an increase in noise in the picture. The increase in noise in the picture results in a decrease in the signal-to-noise ratio resulting in a "snowy" picture.

The next most common distortion is called chrominance gain error. This occurs when chrominance (color subcarrier) is a different gain relative to luminance (brightness). This will cause the color saturation to increase or decrease, through multiple generations.

The chrominance may also be delayed (or more rarely, advanced) relative to the luminance. This is called chrominance-to-luminance delay (or advance) error (inequality). This error will cause the colors to bleed over into the rest of the picture and result in blurred (or smeared) chrominance edges.

There may be also some delay errors in sharpness correction. This will cause white or dark lines to appear before or after sharp edges in scenes as multiple tape generations are performed.

In another example, some non-linear errors cause high brightness level scenes not to have the same frequency response as low brightness level scenes. Additionally, these brightness (voltage level) changes can affect gain and/or delay characteristics from scene to scene.

The chrominance may change phase or gain causing the colors to change.

A change in residual subcarrier will also cause black and white scenes or parts of scenes to have color.

Timing errors or subcarrier jumps can occur between signals due to lock circuits within VCRs or signal processing equipment. These will be most noticeable when keying or dissolving (crossfading) between two signals.

These problems can occur singly or in groups resulting in poor quality video productions. (With all the errors that can occur you must sometimes wonder how you get any results at all.)

Processing equipment now allows for system-error compensation. Improvement can be achieved in your system if it is setup with this type of equipment while being evaluated with a Test Signal Generator and a Waveform Monitor and Vectorscope.

Test Signals

The most popular test signal is COLOR BARS. This signal gives you an amplitude reference for white, either at 100 IRE or 75% saturated white at 77 IRE. (75 percent of the way from setup's 7½ IRE, and peak white at 100 IRE). If the Color Bar does not have a 100% white reference as the first bar, usually the signal is split during the field so that there is a 100 IRE pedestal in the lower part of the picture. The chrominance portion of the Color Bar signal consists of six bars made up of Yellow (Yl), Cyan (Cy), Green (G), Magenta (Mg), Red (R), and Blue (B). The amplitudes and phases of the color bar subcarriers can be detected most easily with a vectorscope. On a waveform monitor, you can check that the peak of Yellow (Yl) and the Cyan (Cy), are at their nominal 100%, and that Red (R) and Blue (B) go equally negative. (On a picture monitor, you can look for correct appearing colors -- although this is subjective.)

The CONVERGENCE pattern is another popular test signal designed to detect deflection non-linearitys in the display picture tube. These parameters include: horizontal and vertical deflection gain, pin-cushion or barrel distortion where the lines are not straight, and convergence errors where the Red, Green, and Blue guns are not tracking accurately as they scan the picture tube's screen.

The MULTIBURST signal is a series of packets at different frequencies held at the same amplitude. These frequency packets are used to detect frequency flatness and slew rate errors. (Slew rate errors will cause the top of the packet to appear at a different amplitude with respect to the bottom relative to the center line.)

The MODULATED RAMP with subcarrier can show differential gain and phase errors.

The LINEARITY STAIRCASE reveals luminance non-linearity.

The FIELD SQUARE WAVE is used to detect low frequency tilt.

A line BAR is used to detect a high frequency tilt during the line.
The PULSE allows checking high frequency response (delay and amplitude) and whether ringing occurs either prior to or after the pulse.

The MODULATED PULSE in which a luminance pulse with subcarrier modulation is added so that the baseline is flat if the chrominance and luminance gains and delays are matched.

These signals detect linearity, amplitude, and delay problems.

Input to Output Comparison

A good way of using test signals is to look at both the output from the generator and the output from the processing equipment, and compare those on a picture monitor, a waveform monitor or a vectorscope. For example, Input A for the picture monitor could be the test signal generator output, and Input B could be the processor equipment output. Switching back and forth between Input A and Input B allows you to make a comparison. (Some waveform monitors have internal channel switching so that both Input A and Input B can be viewed at the same time and you can easily make the comparison.)

Another way to do this, is through a switcher. Using a split screen, use one half of the screen to display the signal from the generator, and the other half to display the signal from the Test Signal Generator.

Another example uses the Magni VGA Producer and the VGA Producer software that is available for creating test signals. For testing a VCR, record the signals onto tape, playback the tape into VGA Producer, lock VGA Producer, and then create a split-screen of the test signals. That way, one-half of the picture monitor would be from the VCR and the other half would be from the test signals and VGA Producer. Doing an input and output comparison in this way, one does not need a waveform monitor or picture monitor to determine signal errors.

Genlock

Signal Generators may be Genlocked (Generator-locked) to incoming video (See Application Note 2 - NTSC Video). The generator will be timed with reference to this signal making them synchronous. (If black burst is routed through the studio, this signal allows the generator to be locked to both sync and burst forming a stable color-frame lock.)

The Magni Signal Creator can lock to any composite signal applied to the reference input. The output can be set (timed) so that it will be in time with signals at other parts of the studio such as those entering the switcher. Two reference inputs are provided and therefore, two timing settings have also been provided. The two timing settings can be used to accommodate for example: two studios, or the master control and an editing suite, or two standards such as NTSC and PAL.

Other Outputs

A test signal generator may have other outputs for locking other equipment to the generator. The most common of these are the sync generator pulse outputs. These are two or four volt negative going signals along with a two volt subcarrier output. The pulses include such items as COMPOSITE SYNC, COMPOSITE BLANKING, BURST GATE, HORIZONTAL DRIVE, VERTICAL DRIVE, HORIZONTAL BLANKING, VERTICAL BLANKING, EVEN FIELD, COLOR FRAME. A BLACK BURST signal is standard for locking equipment in the newer systems.

There may also be a trigger output for locking oscilloscopes and other test equipment to the signal generator.

Multi-format Test Signal Generators have more than one signal output to allow for connection to composite and component video equipment. Component recorders such as S-video (SVHS or Hi8), CTDM or CTCM require two signal outputs. Others may require three outputs in order to record GBR, or Y, B-Y, R-Y signals. Some signal generators also provide digital signal outputs to evaluate digital video recorders.

The Programmable Signal Generator

Fixed format signal generators may not have the exact test signal needed to check your particular distortion. Magni provides programmable signal generators which produce a wide variety of test signals. Test signals for the programmable signal generators are available from Magni, or you may use the special software provided with those products to produce your own test signals.

The new processing equipment makes it essential that you have the right test signal for the job.

Distorting the Output

One important capability of a programmable test signal generator is the ability to distort the output signal to allow analyzing effects on processing equipment due to that distortion. For example:

1. Make the sync amplitude low, to test where sync separation circuitry drops out.
2. Vary the burst amplitude to detect loss of color lock or phase shifts.
3. Vary the line widths on certain lines in the field to simulate VCR head switch.
4. Make lines with signal holes to simulate VTR dropouts.
5. Pulses can be put in at random places to determine what will happen with clamps.

Many other types of distortions may be made, that are specific to certain types of processing equipment.

It can be very revealing to test the response of your Proc. Amps., VTRs and Time Base Correctors (TBCs) to these distortions.

Compensating Pre-Distortion

Some distortions are next to impossible to measure directly. However, a novel method is available to programmable signal generator users that will allow making those measurements. The method is to pre-distort the signal going into the processing equipment with an equal and opposite distortion. Therefore when they are processed, the signals appear correct when viewed on your picture or waveform monitor or vectorscope. Once the output has been corrected, the amount of canceling distortion that had to be added to the signal will be equal to, and opposite from, the amount of error in the processing equipment (assuming all things are equal in response characteristics).

Conclusion

Signal processing equipment (VTRs [VCRs], switchers, TBCs, Frame Synchronizers, etc.) have a number of distortions that will impact signal quality. This is especially true when this equipment is used repeatedly as in the production of multiple tape generations. Remember, errors can be additive with each generation.

The current generation of processing equipment have output parameters that can be changed. Using a Test Signal Generator and the appropriate monitoring equipment, these parameters can be adjusted to make signals correct. Once your signals are correct you will be able to produce higher quality video productions and video tapes.

(As an essential benefit, once all your videotape recorders have been brought up to specification, you should be able to interchange tapes between them and with other users without significant signal differences.)

The combination of a Test Signal Generator, Waveform Monitor, and Vectorscope, will make the process of creating high quality video not only possible, but simple.

Application Note 6 - Installation Suggestions

NOTE >>> If certain terms used in this application note are not familiar to you, refer back to: Application Note 1 - Brightness and Contrast, Application Note 2 - NTSC Video, Application Note 3 - The Waveform Monitor, Application Note 4 - The Vectorscope, and Application Note 5 - The Signal Generator.

Introduction

The MM-400 is a combination waveform monitor/vectorscope. The display for this instrument occurs not on a CRT, but on an ordinary video (picture) monitor. This is done in response to one of the primary design goals: to dramatically reduce the cost of accurate video monitoring.

The realization of this goal will at last allow high-quality monitoring equipment to find its way into production and editing areas where proper monitoring has not previously been cost effective.

Another design goal of the MM-400 is to provide functionality rivaling some of the more costly CRT monitors, yet keep operation simple. To this end, a few well-labeled buttons control all major functions with the more complex functions being selected from easy to use on-screen menus.

Labeled buttons on the control panel provide: input selection, two-line/two-field display selection, vertical and horizontal magnifier selection and H and V positioning. (The combination unit also has waveform/vector selection.)

Rotating the knob on the control panel provides control for most of these functions. Additionally, the button labeled ENTER/EXIT and the five numbered buttons provide selection from the on-screen menus. (The knob also provides phase rotation for the vectorscope.)

Since the output of MM-400 is a video signal, it can be routed in the same manner as any video signal -- through 75 Ohm coax. This feature permits the MM-400 to be located exactly where the signal needs to be monitored, and the video output and control lines for the optional Remote Control to be routed to an operator in a more convenient location.

Installation Suggestions

1. Monitoring Multimedia Productions

The compact size of the MM-400 means it can be placed on any handy surface (on top of your computer for example) and connected to observe video quality anywhere in your multimedia setup. Example: Using Figure 43 as a guide, connect the output of your playback VCR to CHA, loop-through to the input of your computer's graphics encoder to observe your VCR's video. Connect the output of your graphics encoder to CHB, loop-through to the input of your switcher/ effects generator to observe the video/graphics output from your encoder. Connect your switcher/effects output to the input of your VCR. Connect the output of your VCR to CHC, loop-through to your video monitor to observe your finished product while recording and upon playback. With this setup you have pretty well covered your bases...meaning that you should be able to spot trouble and correct it before it becomes a permanent part of your production.

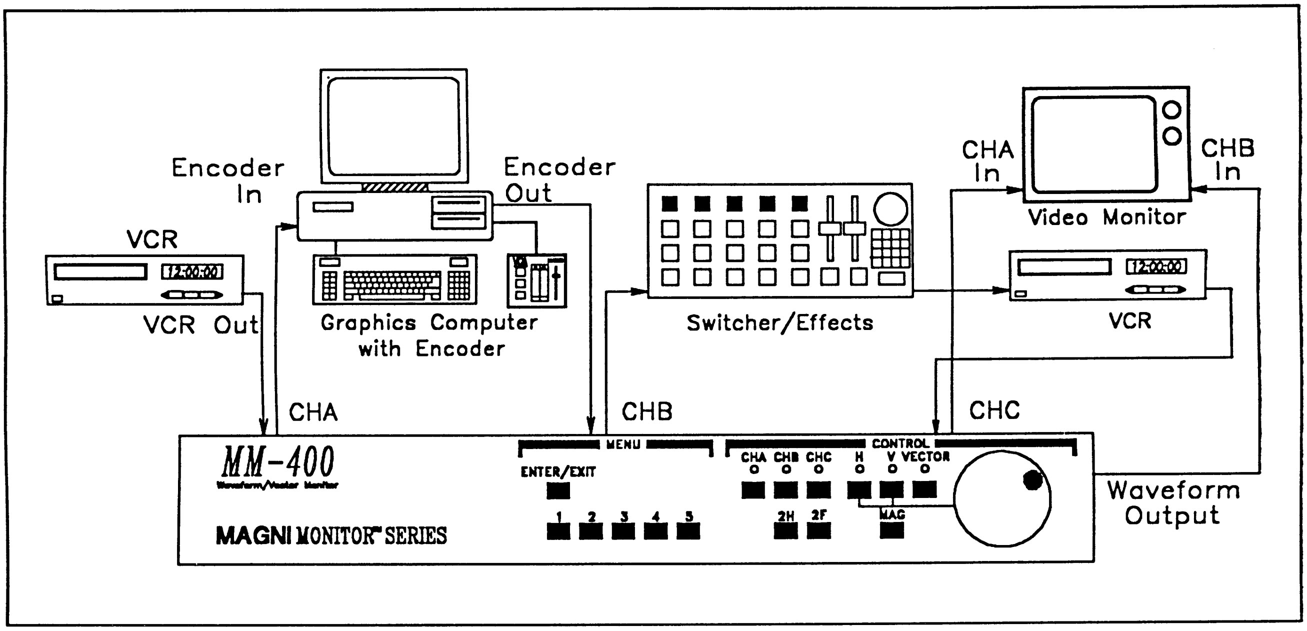


Figure 43 - Sample Multimedia Hook-up

Monitoring the output of the MM-400 is simply a matter of connecting the output to the input of any handy picture monitor. Example: the second (B) input of your regular monitor. In that way you don't need a separate monitor devoted to the MM-400...of course that would be best if one is available.

2. Reporting Problems to a Manufacturer

The output of MM-400 can be recorded on an ordinary VCR thus allowing you to easily document on videotape a problem with a video product or system. Mailing the video tape to the manufacturer is the easiest way to visually describe such problems -- particularly if they are intermittent -- just let the tape run until the malfunction occurs, rewind the tape to a point just before the occurrence, and there's your evidence.

3. Proof Of Performance

There are a number of video printers that will make a hard-copy from a video signal. Since MM-400 outputs the waveform as video, you can make a hard-copy of the waveform video and save it for your files, or submit it as Proof Of Performance, without having to take pictures of dim little CRT displays.

Other Installation Suggestions

Since the operator doesn't need to be physically where the MM-400 is installed in order to monitor a signal, let's think about some situations that will provide for easier signal monitoring:

4. System Setup

MM-400 is quite useful in system setup. For example, the MM-400 can be installed at the monitoring point and the waveform video routed back to a picture monitor at the point where you need to make the adjustment. That way you don't have to run back and forth to see if you've made the correct adjustment.

5. Monitoring a Studio from Master Control

An optional Remote Control can be installed in a different location to control the MM-400. For example: if an MM-400 was installed in a production studio to monitor the output video. The Base Unit can be controlled not only by a Control Panel, but it can be controlled by a second Remote Unit located in Master Control.

The master control located Remote Control and picture monitor can therefore be used to monitor the quality of the output video of the studio at the source.

Similarly, a second MM-400 located in Master Control fitted with a Remote Control located in the studio could be used to monitor the studio signal as it arrives at Master Control, or as it is output from the recording VTR. In this way, operators at either end of the signal path could detect and resolve problems.

6. Monitoring Two-way Interactive Cable Networks

You can monitor any point in a cable system from any other point as long as you have a two-way link. Simply down-convert the channel you wish to monitor to base-band and connect the signal to the input of the MM-400. Take the output of the MM-400 and connect it to a two-way interactive up-converter, and you'll see the waveform back at the head-end.

7. Signal Monitoring in out-of-the-way places

For example, the MM-400 could be mounted in the back of an equipment rack (say, at the input to the STL up in the attic) and the video and control lines routed to Master Control. In this way an operator could continuously monitor the signal at a most crucial spot in the signal path.

8. Transmitter

If you have an unattended transmitter, you can put a modem-connected MM-400 at the transmitter site, connect the Remote Unit to a modem at the studio, and output the waveform video to the return-link for monitoring. In this configuration, you can control the MM-400 from the studio and see what the signals look like at the transmitter.

Distortions in the return-link video will not effect the relationships established in the display video. For example, if there is a 20% loss in the signal coming back, only the display brightness will be affected, not the accuracy of the measurement, or what is seen on the display. The video signal will still indicate the correct gain, because the return signal is a picture of the waveform as seen by the MM-400 at the transmitter site.

An analogy would be: hook up an ordinary waveform monitor to the signal you want to observe. Now point a TV camera at the screen of the waveform monitor. How well or how badly you handle the output of the TV camera will not affect the picture seen on the screen of the waveform monitor - it is fixed. As long as you can get a clear enough picture where the observer is, you can make accurate measurements from the waveform monitor.

The MM-400 works similarly, except that the whole process is done electronically. This eliminates the CRT display of the waveform monitor, its sweep circuits, the TV camera pickup, its sweep circuits, their high voltage and filament power supplies, etc. etc....

9. Monitoring Satellite Transmissions

Since the MM-400 doesn't need to be anywhere near the area that you are monitoring the waveform video, other possibilities such as satellite transmission monitoring come to mind. For example, you could have the MM-400 at the down-link site, and monitor that point from the up-link site. All you need is some way for the MM-400 video output to get back to the up-link point.

10. Remote Video Quality Control

The MM-400 is very rugged and lends itself to use in the field -- particularly with remote camera crews. If you have ever sent an expensive, delicate CRT waveform monitor out with a remote crew only to find out later that it actually traveled out of its case, upside-down, lodged between the spare tire and the shovel, and now has something sticky covering 75% of it, you know the frustration of having to request its re-calibration -- not two days after its last one.

If your remote crews carry picture monitors with them on location, and they check their recorded video on this monitor before returning from an assignment (as they should), the MM-400 can add to this the kind of accurate quality check you'd expect from a CRT monitor -- but much more easily and reliably. Simply run the recorded video into the MM-400, and the output into the picture monitor. If something is wrong, the cause can be determined and remedied.

This simple procedure could save you the trouble (and expense) of having to send the remote crew back out again for a re-shoot.

Unique Features

Now that you have some ideas about Base/Remote/Display Unit installation, let's talk about some of MM-400's unique operational features.

1. Variable Colors

Some dissatisfaction has been expressed within the industry about the colors of both the graticule and the waveform on CRT displays affecting the color perception of production personnel.

It has been shown that color perception can become distorted by looking back and forth between a CRT display and a picture monitor. If you look at something bright green such as a CRT display for a period of time, your eyes will become desensitized to green. When you look away toward a picture monitor, it will appear to have a pinkish cast. Even though this effect goes away after a bit, there is a tendency for production personnel to shade cameras, the outputs of which are viewed on picture monitors, by adding more green -- of course this makes the camera's output too green. Later, as their eyes recover, the camera's color output is accused of drifting first toward pink, then slowly toward green. This phenomenon is especially troublesome when trying to setup (match) multiple studio cameras prior to production. The problem persists throughout the production as the operator tries to maintain camera shading.

When using the MM-400 this is no longer a problem since the display colors: waveform, graticule and background, are adjustable. For example: set the color of both the graticule and the waveform to white, and set the background color to black (Or if it seems more natural, set the background to white and the waveform and graticule to black). These combinations will prevent the problem.

On the other hand, when the display is away from the picture monitors used for production, you may want to select different colors for the waveform, graticule and background either to improve their visibility, or to color-code signals from different sources.

2. Brightness

The brightness level of the waveform drops when MAG and the faster sweep speeds are used. These changes are automatically compensated for in the instrument, however, additional compensation can be added by the operator by adjusting the Brightness Control. In this way, brightness can be set to remain constant between all the modes. The brightness control also allows you to increase the intensity of an area of the signal you wish to examine closely.

3. Persistence

The persistence or decay of the displayed waveform is variable. The settings can be all the way up to infinite persistence allowing capture of any glitches in the signal that go beyond limits, even if this happens, for example, once an hour or once a day. Since the persistence is variable, you can set the persistence so that the vertical interval signals will have a brightness that you can barely see in the background. You can set the persistence so that the VITS, which have a 100% reference, are barely visible in the background. You can then see the gain characteristics of the video compared to the VITS. Basically, you have a full range of persistence from one field to infinite to allow for different monitoring needs. The persistence can also be set to monitor signals with the reference-to-zero carrier pulse found in broadcast demodulators.

4. Picture/Waveform Overlay

The Picture output may be overlaid (Mixed) with the waveform if desired. The menus allow selection of the mix ratio. Quick-key #4 allows you to switch between waveform only, and picture/waveform mix, and picture only.

5. Limits Monitoring, Component Video Timing

The waveform mode has a "timing limits monitoring" capability for component signals. This monitors the timing of the Green (G) to Magenta (Mg) transition of the color bars when viewed in a component mode. If you enable the alarm by selecting 10ns, 20ns, or 40ns, from the component limits menu, the MM-400 will provide a signal through the AUX phone connector on the rear panel if the limites specified are exceeded.

In the component mode, amplitude limit marks on the graticule for R-Y and B-Y levels can be enabled. The limit marks near the 50 IRE levels of both R-Y and B-Y are equivalent to ± 5°. The marks near 0 IRE and 100 IRE are ± 5%. For each of the bars in a color bar signal, one component is equivalent to degrees and another is equivalent to percent.

6. Limits Monitoring, Composite Video SC/H & Color Frame

The vectorscope includes SC/H phase monitoring capability. You can set the limits to ± 10°, ± 20° or ± 40°. Limits monitoring provides an indication on the display that SC/H is within the limits, or if the limits are exceeded and, in which polarity. An alarm can be set to signal when the signal goes out of limits.

Color frame match, when enabled, shows C/F O.K. or C/F ERROR on the display. The unit detects color frame match between CH C and CH A when CH A is on, or between CH C and CH B when CH B is on. The CH C signal should be looped through to the Reference input. This connection method allows monitoring the reference with CH C. An alarm can be set to signal if Color Frame error is detected.

Switcher Drive

The alarm can drive the remote input of a switcher thereby allowing the operator to view the video normally until there is an alarm condition (or the alarm function button is actuated), whereupon it changes to the waveform display to allow the operator to correct the condition. (See Quick-Keys description below.) For example, this could be applied in an editing suite where only one picture monitor is available.

Lock Mode

The MM-400 allows the selection of crystal lock or VCR lock. If a signal being viewed is stable, you should have the crystal lock enabled so that you will have the sharpest display of the waveform. However, when monitoring a VCR output where jitter is present, you should switch the instrument to the VCR oscillator mode.

The VCR oscillator will work on a stable signal, however, there may some slight increase in jitter.

Factory Preset

If your controls have been badly miss-set, you can return to the factory settings by selecting *RESET* from the menus. This allows you to return the MM-400 to the original factory presets and start over.

The factory settings are as follows:

Colors: Background - Black, Graticule - Grey, Waveform - Green

Channel A - Selected
MAGnifier - OFF
REFerence - INTernal
SC/H, Color Frame - Off
Vertical MAG - Blanking
GAIN - Fixed
Clamp - Slow
Picture Mix - Nominal (50%)
Intensity - Nominal
Graticule - Enabled and on top
+V - Off

Selection Mode - Self Cancel
Lock - Crystal
Field Trigger - Even
Sweep - 2H
Timing - Off
Filters - Off
Auto Format - Detect ON
Variable Gain - Off
Persistance - Nominal
Vectors - 75%

Menu Operation

Under MENU on the Control Panel are six buttons; five numbered 1-5 and one labeled ENTER/EXIT. To access the menus, push the ENTER/EXIT button. (Pushing ENTER/EXIT again exits the menus.) The buttons labeled 1-5 are for selection within the menus. If you access a menu and select a function within that menu, the instrument immediately performs the function and switches back to the normal display.

NOTE >>> Setup Functions (number 5 on the first menu) is normally accessed only upon installation of the instrument.

While the menus are a user-friendly method of setting the more complex functions, the nine buttons under CONTROL select the most-used functions making the instrument easier for experienced and inexperienced operators to use.

Labels

The output of the MM-400 may be routed as a normal video signal. A 10-letter label can be placed at the bottom of the picture to identify the signal.

Channel Selection

There are three channel selection button switching modes. These allow for tailoring channel selection to suit the operator's preference. The modes are as follows:

1. Self-Canceling - Only one signal can be viewed at a time.

2. Push On, Push Off - Each input can be toggled ON/OFF similar to an oscilloscope.

3. Push On-Cancel - The first push of an input button switches that input on. Inputs already on remain on. The second push of the same input button cancels the other inputs leaving only the selected input on.

Summary

MM-400 uses new concepts to reduce monitoring costs, provide greater flexibility, and help produce higher quality video.

5. Specifications

Waveform Monitor/Vectorscope

Standards	NTSC, PAL, Component Analog, S-Video (S-VHS or Hi8)
Inputs	3 channels - BNC loop-through video inputs (2 with S-Video interconnect) 1 BNC loop-through reference input
Outputs	1 monitor output 1 picture output with switch to monitor feature
Accuracy	
White Bar Amplitude	±2%
Sync	±3%
Burst	±3%
Frequency Response	±3% to 5 mHz
Displays	
Waveform/Vector	Variable color and intensity
Graticule	Electronic variable color and intensity
Gain	±3dB, detent at 1X and 2.5X (Calibrated with 75% and 100% CB)
Chroma Demod BW	750kHz nominal
Vectorscope	
Phase	360° continuous rotation
SC/H phase	Warnings at ±10° , ±20° , and ±40°
Waveform	
Display Formats	Single input, parade of inputs or filters
Sweep Speeds	1H, 2H - Magnify to 1µs/div or 0.2 µs/div 2F - Magnify to 25X or 50X
Interchannel Timing	Warnings at ±10ns., ±20ns., and ±40ns.

Vertical Resolution	140 IRE/1V (NTSC); 1V/1V (PAL)
Sampling Frequency	6.75 MHz dithered to 864 MHz equivalent
Mechanical Specifications	Height 1.75" (45 mm) Width 19.0" (480 mm) Depth 12.0" (305 mm) Weight 6.5 lb (2.9 kg) Front or rear mountable
Optional Remote Control	Height 5.25" (133 mm) Width 3.35" (85 mm) Depth <2.0" (51 mm) Weight <8.0 oz (<0.25kg) RJ11 connector on Rear Panel
Power Supply	External, DIN connector to MM-400 +12 Volts @ 1.5 Amps., -12 Volts @ 300 mA. +5 @ 2.0 Amps

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